76-1575

IN THE

Supreme Court of the United States

OCTOBER TERM, 1976

No.

CONTROL DATA CORPORATION, *Petitioner*

v.

TECHNITROL, INC., *Respondent*

APPENDIX TO PETITION FOR WRIT OF CERTIORARI TO THE COURT OF APPEALS FOR THE FOURTH CIRCUIT

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United States Court of Appeals

FOR THE FOURTH CIRCUIT

No. 75-1857

TECHNITROL, INC.

Appellant

v.

CONTROL DATA CORPORATION

Appellee

Appeal from the United States District Court for the District of Maryland, at Baltimore. R. Dorsey Watkins, District Judge.

Argued February 4, 1976 Decided March 8, 1977

Before WINTER, RUSSELL, and WIDENER, Circuit Judges

S. C. Yuter (Yuter and Rosen on brief) for Appellant; Allen Kirkpatrick (Kevin E. Joyce, Larry S. Nixon, Cushman, Darby & Cushman, and Joseph A. Genovese, Control Data Corporation on brief) for Appellee.

WIDENER, Circuit Judge:

This patent case concerns an automatic reset feature, a device to prevent information loss in a magnetic data storage system. Technitrol, Inc., the patent owner, brought an infringement suit for an injunction and damages against Control Data Corp., a manufacturer, seller, and user of such systems. Control Data filed a counterclaim asking the court to declare Technitrol's patent invalid and moved for summary judgment for failing to comply with 35 USC § 112, para. 2, which reads in pertinent part:

> "The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention. . . ."

Looking to an affidavit by an expert filed by Control Data, the record of an allied case in the Court of Claims, and the language of the patent itself, the district court held claims 1-15 and 17-24 invalid as

not "particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention," 394 F.Supp. at 520, relying on paragraph 2 of § 112 and rejecting the defendant's position that the claims are adequate under paragraph 3 of § 112. Sua sponte, the court also granted summary judgment for the defendant on the remaining claim 16 based largely on its holding as to the other claims. Technitrol now appeals.

We are of opinion that the claims adequately describe the invention as we consider them here. We therefore vacate the district court's grant of summary judgment and remand for further proceedings.

I

Technitrol's patent was originally issued to T. K. Sharpless and E. S. Eichert in 1952 as No. 2,611,813. By assignment, Technitrol is, and at all pertinent times has been, the owner of the patent.

The patent describes a computer system used, for example, in making airline reservations, composed of a central storage unit where information about various flights is stored, and a number of remote stations, such as airport reservation desks, which communicate electrically with the central unit. An

operator, by punching certain keys on the keyboard at the remote station, can ask the central storage unit whether seats are available on a particular flight. If seats are available, the invention can make reservations on flights, or it can cancel them, or it will indicate if a flight is full.

The remote stations communicate with the central storage unit through electrical transmission lines. Each remote station has keyboards by which an operator can designate a particular flight about which he desires information and the number of seat reservations needed.

The keys, through appropria circuitry, indicate to the central station the register which contains information about the desired flight. After setting the keyboard, the operator presses a start switch which operates a selector circuit to insure that only one keyboard at a time can communicate with the central station. This avoids the possibility of simultaneous duplicate requests to a register from more than one remote station.

To make reservations, the operator communicates the number and flight to the central storage unit. There, the total number of seats and confirmed reservations of each particular flight is stored on a corresponding register. When the operator selects the appropriate flight number, the machine selects the corresponding register and adds the number of reservations desired to the previous total. If the sum of these is less than the total of reservations available, the reservation request is confirmed, the number of reservations requested is added to the previous total, and the new total is recorded in the storage register where it is available for similar access in the future. But if the sum exceeds the total of reservations available, the application is rejected, the inquirer is so notified, and the old number remains unchanged.

The central storage unit is a magnetic memory device consisting of several continuously revolving magnetic disks (information disks 2, 3, 4, 5)[1] mounted on

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1. Fig. 4 appended hereto is used for numbered or lettered references.

a common rotating shaft. An electric motor drives the shaft. Information is stored on the disks in magnetic pulses, which, when arranged in groups around the disk, are called registers, one group being one register. Each register contains information about a particular airline flight such as the number of seats already reserved and the number still available.

Magnetic recording heads (C, D, E, F) are mounted adjacent to the disks. These either read what is on the disk, add to it, or erase from it. Thus, as the disks rotate on the shaft, the recording heads, through appropriate circuitry, can read or erase the magnetic pulses already recorded, or can place new pulses on the disks.

Also located on the common shaft with the information disks is a master clock disk (1). Around the clock disk, two channels of magnetic pulses are recorded. One channel has 160 evenly-spaced pulses; the other, one pulse. Magnetic pickup heads (A, B) are located over each channel. The 160-pulse head is connected to a scale-of-ten counter (b) which divides the information from the disk into sixteen 10-pulse

registers. Pulses from the scale-of-ten counter, when applied to a binary counter device (c), produce 16 unique voltage combinations, each one of which corresponds to one of the registers on the information disk. The unique voltage combinations (originating at the various registers)are successively fed into a coincidence circuit (d).

When the remote station operator pushes the key to select a particular register, the key generates a voltage combination corresponding to one of the unique voltage combinations originating on the rotating disk which is also fed into the coincidence circuit (V_1, V_2 V_3, V_4). When the disk rotates to the particular register so that its voltage combination matches the one generated by the operator, the coincidence circuit detects the coincidence and produces an output activating the magnetic recording heads (C, D, E, F) which read, write, or erase.

There is general agreement here (not later binding) that a previous magnetic storage system or systems accurately located the registers as long as operation continued without interruption. When

interrupted, however, as by a power failure or merely cutting the control station off, position volatility occurred and the information was lost. In essence, this means that the clock disk and the counters, normally in synchronization, lose synchronization when power is cut off. This happens because the counters, electronic devices, stop operating when power stops; and because of rotational inertia, the disks, being mechanical devices, may rotate slightly after the power is cut off, and thus may move out of synchronization with the counter. On restart, the counters, which have lost count of the physical location of the registers, do not pick up the count where they left off with the corresponding register. On start-up, therefore, it is essential that the counters be reset to synchronize them with the registers.

The Sharpless-Eichert invention does this by the one-pulse-per-revolution channel on the clock disk. The single pulse resets the counters to zero, whether after each revolution of the clock disk or only on start-up is not material here. Even if the power goes off momentarily, causing the counters to start up with

arbitrary counts, within one revolution the invention will synchronize the counters to the correct count.

In order to simplify this appeal, Technitrol has limited its argument to representative claim 19.[2]

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2. 19. In an information storage system, magnetic recording means having a plurality of information recording sections constituting registers and also having a register-selection section on which are recorded pulses coordinated with said registers, means for producing from said recorded pulses different successively-occurring register-selection voltage combinations representative respectively of said registers, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage and said voltage pattern for selecting said register, and means for storing said numerical information in said register.

It takes the position that the reset feature appears there. Because we think it is for the purpose of this motion, we do not address the arguments regarding the other patent claims. Although Control Data apparently takes the position that claim 19 is not representative, it fails to state why, only offering the conclusion. Since the case will be remanded for further proceedings, the district court may take appropriate action to any extent it may properly determine that a claim is not representative when considered in the light of this opinion.

We emphasize that the case comes to us as an appeal from the grant of summary judgment holding the patent claims invalid. While summary judgment may be proper in patent infringement cases, it is only where, under FRCP 56(c), there is no genuine issue as to any material fact and the moving party is entitled to a judgment as a matter of law. Smith v. General Foundry Machine Co., 174 F2 147, 151 (4th Cir. 1949), cert. den. 338 US 869 (1949). It should be employed with great caution, Morpul, Inc. v. Glen Raven, 357 F2 732 (4th Cir. 1966), and is not ordinarily appropriate for the disposition of a patent case. Long v. Arkansas Foundry Co., 247 F2 366 (8th Cir. 1957). As the moving

party, Control Data has the burden of showing the absence of a genuine issue of material fact. Adickes v. Kress & Co., 398 US 144, 157 (1969).

In support of its motion, Control Data submitted an expert's affidavit which concluded that the claims did not adequately describe the automatic reset feature. The district court referred to the affidavit as uncontroverted. But in our opinion it was not, and in all events had to be construedin the light most favorable to the plaintiff. Adickes, p. 157. The court also had before it the report of a Court of Claims Commissioner,[3] the opinion of the Court of Claims, and

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3. The suit in the Court of Claims included an issue arising because Sharpless and Eichert, the inventors of the automatic reset feature, had been employed by the University of Pennsylvania under a U. S. Navy contract to do research on the ENIAC and EDVAC government contracts. Under this contract, research associates were to grant to the United States a royalty-free right and license to all discoveries and inventions growing out of the research. When the government manufactured and

Fn. 3 continued -

used the inventions of the Sharpless-Eichert patent, Technitrol brought suit in the Court of Claims to recover compensation for the unauthorized use.

The commissioner recommended to the court that it find the government not licensed under the patent, but the court did not wholly adopt his recommendations. It found, instead, that the government was licensed "except to the extent that those other claims may be limited to the system's automatic reset feature." Technitrol, Inc. v. United States, 440 F2 1362, 1364 (Ct. Cl. 1971). That decision rested on the fact that the reset feature was the only portion of the patent disclosure invented after the inventors left the employ of the government's contractor.

But the court declined to pass on the question of whether that feature was adequately described in the claims, stating:

> . . .In determining validity, as the Dominion case [Dominion Magnesium Ltd. v. United States, 320 F2 388 (Ct. Cl.

Fn. 3 continued -

> 1963)] and many others illustrate, courts must frequently choose between a narrow construction of the claims that upholds the patent and a broad construction that strikes it down. We do not wish to make that choice at this stage, believing that it would be both unwise for the court and unfair to the parties to affix a meaning to the claims in the absence of further proceedings, including the making of a record, on validity. 440 F2 at 1369.

Control Data urges us to disregard the findings of the commissioner who had construed representative claims, including claim 19, so as to include the reset feature, because his report was not followed by the Court of Claims. While it is true that the court did not wholly follow his recommendations, it decided the case on other grounds and specifically did not decide the issue of whether the automatic reset feature was included in the claims of the patent as just above stated. We neither

the record in the Court of Claims which included expert testimony. We note the district court in its opinion referred to all of this additional information.

It seems to us that what the district judge did was to adopt the opinion of the expert for Control Data and to disregard the testimony and other proof favoring Technitrol. Since letters patent are contracts, they should be construed with the interest of the parties in mind to give effect to their legitimate expectations. Del Francia v. Stanthony Corp., 278 F2 745, 747 (9th Cir. 1960). And, while matters of construction are ordinarily for the court, "[t]he claim of a patent must always be explained by and read in connection with the specifications." American Fruit Growers, Inc. v. Brogdex Co., 283 US 1, 6 (1931). Although in a simple and clear-cut

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Fn. 3 continued -

accept nor reject finally the commissioner's construction of claims although his reasoning is persuasive.

The opinion of the district court is reported at 394 F.Supp. 511 (D. Md. 1975), and the report of the commissioner in the Court of Claims at 164 U.S.P.Q. 51 (Ct. Cl. Commr. 1969).

case, it may be proper to disregard one party's evidence, see Ethyl v. Borden, Inc., 427 F2 206, 208 (3rd Cir. 1970), where there is conflicting evidence before the court, as here, disposing of the issue on motion for summary judgment is not proper.

It may well be, as Technitrol argues and as the commissioner found in his report to the Court of Claims, that the term "representative" in clause 2 of claim 19 points out the automatic reset feature. Shaw's testimony before the commissioner can be construed that way when read in the light of the rules of construction we have recited just above. And, perhaps the patentees could have been more thorough in their patent claims. One part of the opinion of the district court suggests this may have been their only error. p. 517. Nevertheless, they have "the right to use such words as to [them] best describe [their] intention, and they will be so construed as to effectuate that result." Bianchi v. Barili, 168 F2 793 (9th Cir. 1948) (quoting H. J. Wheeler Salvage Co. v. Rinelli & Guardino, 295 F.Supp. 717,727 (D.C. N.Y. 1924). The rule is that patentees are allowed much latitude in terminology, and their language will be

accorded the meaning intended if it can be ascertained from the context. Strong-Scott Mfg. Co. v. Weller, 112 F2 389 (8th Cir. 1940) (citing Smith v. Goodyear Dental Vulcanite Co., 93 US 486, 494-95 (1876). See Topliff v. Topliff, 145 US 156, 171 (1892).

Everyone admits that without the reset feature the system was position volatile. And the record supports the conclusion that Sharpless and Eichert intended their system to be one unhampered by position volatility. To be so, it was essential that the disks and the counters stay in synchronization. Otherwise, the counters might not produce signals representative of each register on restart.

The grant of a patent is some evidence that the patented device is operative. Dashiell v. Grosvenor, 162 US 425, 432 (1895). To be patentable, the device must be useful. 35 U.S.C. § 101. Certainly it would have to work in order to be useful. Brenton v. Mishcon, 93 F2 445, 448 (2d Cir. 1937).

Without the automatic reset feature to insure that the counters produce signals representative of each register, whether or not following a loss of power, the

Sharpless-Eichert patented invention would not work as intended. We are of opinion that the claims at issue should not be construed so rigidly as to defeat the utility of the device as the inventors intended it. We think the use of the term "representative" without qualitication could easily have meant that the signals would always represent the proper register. That is how their system worked, and based on this record, that is what we think they intended to claim.[4]

In any event, it is an established principle of patent law that when a claim is fairly susceptible of two constructions, one will be adopted which will preserve to the patentee his actual invention. Coupe v. Royer, 155 US 565, 577 (1894). In this case, at least two electronic experts who gave opinions did not agree on the effect of the inventor's claim descriptions. We think, for the purpose of summary judgment, that this indicates at the least the claim may be susceptible of two constructions.

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4. Technitrol takes the position clauses 1 and 2 of claim 19 disclose the reset feature.

We are supported in our conclusion by the third paragraph of 35 USC § 112, which is:

> "An element in a claim for a combination may be expressed as a means or step for performing a specified function without the recital of structure, material, or acts in support thereof, and such claims shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof."[5]

---

5. The third paragraph of § 112 was added in 1952. There seems to be general agreement that it was intended to ameliorate the effect of Halliburton Co. v. Walker, 329 U.S. 1 (1946), and to restore the authority of Continental Paper Bag Company v. Eastern Paper Bag Company, 210 U.S. 405 (1908). Halliburton and Continental narrowed and broadened, respectively, functional claiming. The following articles to some extent or other address the addition, and we have considered them in the preparation of this opinion. Smith,

We begin with the proposition that the claims measure the invention. Continental Paper Bag Company v. Eastern Paper Bag Company, 210 U.S. 405, 419 (1908). (Continental Paper Bag is referred to also in footnote 5).

Remembering that the district court held against the patent in question because in its opinion

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Fn. 5 continued -

Functional Claims and the Patent Act of 1952, Journal of the Patent Office Society, July 1966, Vol. XXVIII, No. 7; from the same Journal, Vol, XXXVII, Oct. 1955, No. 10, Riesenfeld, The New American Patent Act in the Light of Comparative Law, Part II; Wachsner, Commentaria, Functional Claims.

The case before us has been commented upon in Patent Law Perspectives, 1969-70 Annual Review, § E.1; and in 1975 Developments, § A.5. The editors, in general, would seem to be in agreement with our conclusion.

the claims did not particularly point out and distinctly claim the subject matter which the applicant regarded as his invention, 35 USC § 112, paragraph 2, we also are of opinion that a valid rule of construction with respect to paragraph 2 is correctly expressed in Application of Lundberg, 244 F2d 543 (C.C.P.A. 1957), that the requirements of the second paragraph of § 112 just above mentioned are not diminished by the addition of the third paragraph, also above mentioned.

We think a correct construction of the third paragraph of § 112 has been stated in Application of Knowlton, 481 F2d 1357 (C.C.P.A. 1973). There, the paragraph was described as dealing with permissible forms of claiming (italics from Knowlton), and, after reciting some of the language from the statute, the court stated the rule adopted was that "If the applicant chooses to use such language, the statute instructs the interpreter of the claims, e.g., the Patent Office or the courts, as to how such language shall be interpreted." p. 1366. Thus, the third paragraph is held to deal with permissive claiming; and, if language coming within the statute is used in the claim, directs how the courts shall construe that

language. Knowlton also acknowledges that it does not dispense with the definiteness requirement found in the second paragraph of § 112, as we have just above recited from Lundberg.

We also think a correct construction of the third paragraph of § 112 is found in Stearns v. Tinker & Rasor, 252 F2d 589 (9th Cir. 1957), in which the court stated: "We construe the section to mean that while an element in a claim for a combination may be expressed as a means or step for performing a function without recital of structure, material, or acts in support thereof; the structure, material, or acts must be described in the specification, and if so described, the claim will be construed to cover that which is described and the equivalents thereof. But the structure need not as well be recited in the claim." p. 597-598.

In the use of means clauses in patent claims, a "means for" clause such as those used here ". . .in effect calls for structure - more precisely - for apparatus or, indeed, for any physical body or bodies having the capacity to perform the function recited after the words 'means for'. Such a clause is completely devoid of the details of apparatus capable of satisfying the recitation of function. Indeed, a 'means clause' (consisting of the words means for and

a statement of the function which such means is supposed to perform) is to be construed as calling for ANY means capable of performing the indicated function." Rosenberg, Patent Law Fundamentals (1975), p. 48.[6]

With these principles in mind, we turn to the question at hand. Technitrol claims the reset feature is disclosed in clauses 1 and 2 of claim 19, which are:

> "Claim 19 [repeated for convenience]
>
> "In an information storage system,
>
> "1. magnetic recording means having a plurality of information recording sections constituting registers and also having a register-selection section on which are recorded pulses coordinated with said registers,
>
> "2. means for producing from said recorded pulses different successively-occurring register-selection voltage combinations representative respectively of said registers,"

We are unable to ascertain precisely why the district court held that there was insufficient disclosure under paragraph 2 of § 112. It may have been

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6. (page 22a)

Fn. 6

We are aware that means and function claiming results in quite broad claims which are to greater or lesser extent limited by the specifications. We do not have before us at this time the question of the extent to which the claims here should be limited. See Deller's Walker on Patents, 2nd ed., e.g. §§ 248 and 255.

because it thought there was no causal relationship between the specified function and the "apparatus purportedly included" in the means clause. 394 F.Supp. at 516. Or it may have been because of the mere omission of the words "in conjunction with the automatic reset function," which is more strongly suggested on p. 517.[7]

In either event, we think the court was in error.

Both clauses 1 and 2 of claim 19, for example, refer to a register-selection section, and clause 2 of

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7. If it be thought that the reason the district court held against the claim was because it thought the claim did not include a function, we think that it did as explained in the body of the opinion.

Needless to say, the decision of the district court on claims 5 and 23 will have to be reconsidered in the light of this opinion.

the claim provides that the different successively occurring register selection voltage combinations are to be "representative respectively of said registers." Clause 2 also provides a "means for" producing such "voltage combinations representative respectively of said registers."

Referring back to the first part of this opinion in which the problem to be solved, as acknowledged by all, was shown to be position volatility, we think the invention would not work in the manner conceived by the inventor if it were position volatile. This is so because the voltage combinations would not be representative respectively of the registers at each necessary place in the system in an apparatus which was position volatile. The voltage combinations in such a position volatile apparatus might well be not so representative after power failure or cutoff as we have before described.

Considering that clause 2 of claim 19 is in one of the permissible forms of claiming under paragraph 3 of § 112, since it expresses a "means or

step for performing a specified function," we think the specified function is the production and transmission to necessary places in the system of voltage combinations "representative respectively of said registers" and not of something else. That being true, it is not necessary that the claim recite a "structure, material, or acts in support thereof," for it "shall be construed to cover the corresponding structure, material, or acts described in the specification and equivalents thereof." § 112, paragraph 3.

The clock disk and reset feature is mentioned at various places throughout the specifications, but for our present purpose we need mention only one. Column 4, line 33, contains the following language:

> "The one pulse per revolution output supplied from the clock disk 1 through amplifier a1 is used to initially set the counters so that the registers on

> the disks will always remain the same relation with the pulses on the clock disk as checked by counters b and c, even though the power be shut off and later turned on with the counters coming up containing arbitrary counts."

Thus, by reference to the specifications in accordance with paragraph 3 of § 112, we think the clock disk and its function, which amounts to the reset feature, is covered as a corresponding structure or act as a part of the claim and helps serve to prevent invalidity for indefiniteness. See opinion of the Patent Commissioner, 164 USPQ at 55-56. We think our construction of the language used is consistent with Continental Paper Bag Company (the claims measure the invention); with Lundberg (we have not diminished the effect of the second paragraph by reference to the third paragraph of § 112); with

Knowlton (in permissible claiming, we have construed the language of the claim as directed by the third paragraph of § 112); and with Stearns (the structure is recited in the specifications, although it need not as well be in the claim).

We are therefore of opinion that the district court erroneously construed the claims for the reasons set forth just above, as well as those in Part I of this opinion.

III

The order of the district court adjudging claims 1-24 inclusive of the '813 patent to be invalid must be vacated and the case remanded for further proceedings not inconsistent with this opinion.

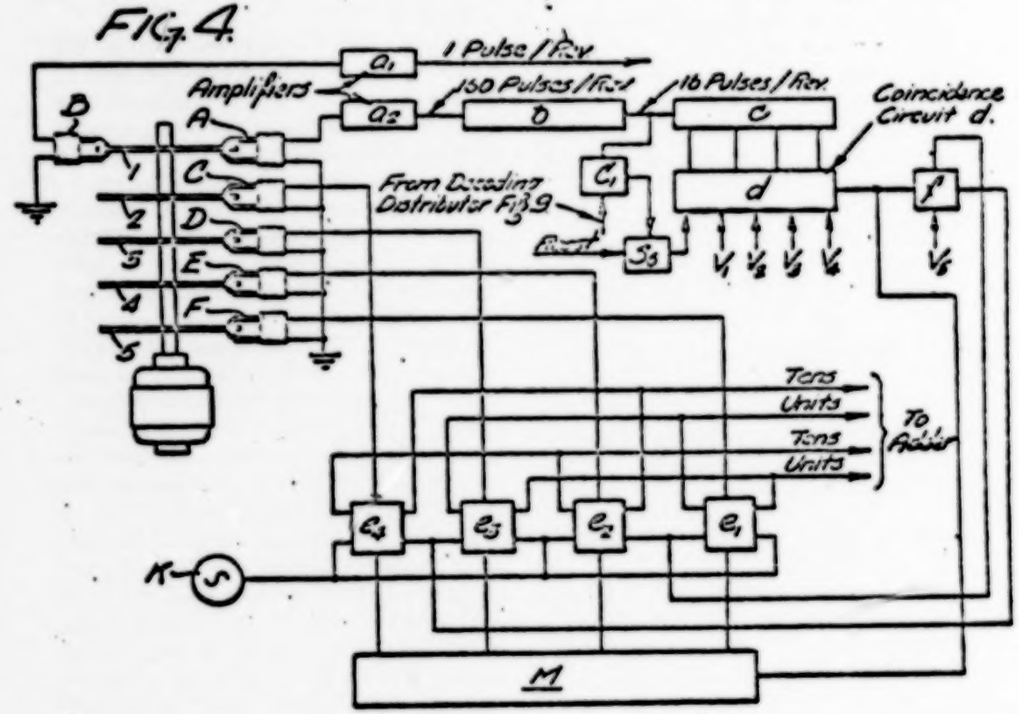
VACATED AND REMANDED.

Sept. 23, 1952 T. K. SHARPLESS ET AL 2,611,813

MAGNETIC DATA STORAGE SYSTEM

Filed May 26, 1948 7 Sheets-Sheet 2

FIG. 4.



394 F. Supp. 511

TECHNITROL, INC., Plaintiff,

v.

CONTROL DATA CORPORATION and Honeywell, Inc., Defendants.

Civ. A. No. 17653.

United States District Court, D. Maryland.

May 13, 1975.

WATKINS, Senior District Judge.

On September 23, 1952, U.S. Patent No. 2,611,813 (the '813 patent) for "Magnetic Data Storage System" issued to T. K. Sharpless and E. S. Eichert, Jr. on application filed May 26, 1948. By mesne assignments Technitrol, Inc. is, and at all pertinent times has been, the owner of the patent.

In addition to the specification and drawings, the general nature of the alleged invention[1] is set forth in litigation in the Court of Claims in which Technitrol sued the United States for "reasonable and entire compensation" for alleged unauthorized use of inventions assertedly described and claimed in the '813 patent. *See* Technitrol, Inc. v. United States, Court of Claims (before a Commissioner), 164 USPQ 51, 52–53 (1969) and Technitrol, Inc. v. United States, 440 F.2d 1362, 1364–1366, 194 Ct.Cl. 596 (1971).

At the risk of over-simplification, the primary object of the invention was to provide means by which various offices or agencies ("positions") could quickly ascertain the availability (or non-availability) of airline seat reservations for a particular flight. The total number of seats available is stored in a register (a length of magnetic tape or a sector of a magnetic disc) and the number of confirmed reservations is also recorded. If an outside station desires to make reservations, data as to the number and flight are communicated to the centrally located storage unit. The appropriate storage register is selected, and the number of additional reservations desired is added to the previous total. If the sum of these is less than the number of available reservations, the two are added to provide a new total which is then stored back in the corresponding storage register where the new total is then available for similar access in the future; and the inquiring station is so notified. If the requested additional reservation, added to the reservations already made, would exceed the total of reservations available, the application is rejected, the inquirer is so notified, and the old number remains unchanged.[2]

All this involves a process of register selection; that is, it is necessary to locate a particular register later, and perhaps several times, in order that the previously stored information content may be accessed for a desired use. Until January 7–9, 1948 the proposed system, once it had started operation, permitted such accurate location of registers as long as it continued operation without interruption. However, if there were an interruption, such as by a power failure, "position volatility" may occur.

1. Plaintiff claims that '813 embodies four or five inventions, of which several apparently are claimed in the same claim. As a result of proceedings in the Court of Claims not more than two inventions need be considered.

2. This "store-if-no-exceed" feature was added in March 1948.

As Commissioner Davis very clearly explained (164 USPQ at 52–53):

> A particular aspect of the invention, significant to the license dispute here in issue, relates to the so-called memory reset feature by which position volatility of the system is avoided. To explain, on the common shaft with the information disks is a master or clock disk which has recorded around its face two channels of magnetic pulses —one channel has 160 evently-spaced pulses, the other 1 pulse. The purpose of the clock disk, as its name implies, is to serve as a timing device to coordinate the timed-position of the information disks with other elements and circuits of the computer system. A pickup head is located over each channel. Thus, one head produces 160 evenly-timed pulses per revolution of the clock disk, the other one pulse per revolution. The 160-pulsehead is connected to a scale-of-ten electronic counter which produces one output signal for each 10 input pulses. Thus, the counter generates 16 pulses (160/10) for each revolution of the clock disk, and it thereby divides the information disks (on a common shaft with the clock disk) into 16 10-pulse registers, or information segments. Pulses from the scale-of-ten counter are applied through electronic circuitry to a digital counter which in turn produces 16 unique voltage combinations, each thus representative of one register on an information disk. When one of the voltage combinations matches up with, or coincides with, a similar combination from a remote station (generated by an operator seeking information about a particular flight, or register), circuitry is activated by which the register is used.
>
> It can be seen from the above that it is essential for the clock disk and the scale-of-ten counter to stay in synchronization. Otherwise, the counter will not produce signals representative of each register; or, to say it another way, the system would be position volatile. During normal operation, with power on and the equipment functioning properly, the clock disk and counter will stay synchronized. However, at startup initially, or after a power failure, the clock disk and counter may lose synchronization, e. g., if the clock disk continues rotation momentarily through inertia after electric power is cut off the counter and the motor. Also, when power is cut off, the counter, a purely electronic device, loses count; and on restart, its counts may not be synchronized with the start of a register on an information disk so that such counts would be arbitrary with respect to register positions. Thus, some means must be provided to synchronize the clock disk and counter on startup. The one pulse per revolution channel on the clock disk serves that purpose. It is connected through appropriate circuitry to reset the counters to zero after each revolution of the clock disk, thereby synchronizing the clock disk and counter if they are out of synchronization.

This automatic reset figure was Eichert's direct contribution to the system, developed by him January 7–9, 1948.[3] It is briefly described in the specification (Col. 4, lines 33–40):

> "The one pulse per revolution output supplied from the clock disk 1 through amplifier a_1 is used to initially set the counters so that the registers on the disks will always maintain the same relation with the pulses on

3. Until then Eichert appears only to have made some suggestions as to Sharpless' drawings. Who is primarily responsible for the "store-if-no-exceed" feature is not clear, but it is not important for the disposition of the pending motion.

the clock disk as checked by counters b and c, even though the power be shut off and later turned on with the counters coming up containing arbitrary counts."

Frequent other references to "reset" occur in the specification, e. g., Column 4, lines 62 and 65; Column 5, line 41; Column 10, lines 5, 6, 14, 19, 22, 64 and Column 13, line 61. Nevertheless, the clock disk and assorted counters "are not expressly recited in any of the claims" (164 USPQ at 53) and Plaintiff so "concedes" (164 USPQ at 55); but Commissioner Davis held that they were included in claims 1–15 and 17–24 "in broad 'means' clauses" (164 USPQ at 53).

The significance of the automatic reset feature was stressed by Commissioner Davis in that it was only with the reset feature that *the* invention claimed in claims 1–15 and 17–24 occurred. 164 USPQ at 56:

> The record is clear that while Sharpless did considerable preliminary design work on the reservations system in mid-1947, it was not until early 1948, when working full time for Technitrol, that the problem of position volatility was recognized and solved by Eichert. Only then was there a complete system, as envisioned by the inventors and later disclosed in their patent application. Defendant makes much of the fact that a position volatile system is nevertheless operable in a legal sense because the problem of position volatility only arises at initial startup and startup after a power failure. Thus, defendant reasons, there was conception of the invention in suit before the position volatility problem was recognized and solved. In our view, however, while there may have been conception of *an* invention before Eichert came on the scene, it was not *the* invention disclosed and claimed in claims 1–15 and 17–24 of the patent in suit. The Sharpless and Eichert invention included the memory reset feature and it is *that* invention with which we are here concerned . . . . "

Plaintiff concurs in this conclusion. In its statement of "Postion" it says (page 9):

> ". . . The memory synchronization solution feature for register selection is claimed in claims 1–15 and 17–24 . . . . "

Further, in "Plaintiff's Brief Opposing Defendant's Brief in Support of its Exceptions to the Commissioner's Report," filed July 2, 1970, Plaintiff stated:

> . . . Thus, the Commissioner's construction of the representative claims 23 and 5, directed to different aspects of the inventory control problem, substantially narrowed the scope of these two representative claims by incorporating into them the memory synchronization feature on the magnetic data storage invention defined by representative claim 19.
>
> *After studying the legal basis for the Commissioner's narrowing construction of the representative claims 23 and 5, plaintiff has acquiesced.**
>
> The result is that there are two independent and distinct inventions involved; the claim 19 invention and the claim 16 invention . . . .
>
> *As a practical matter, this means plaintiff's present position is that inventory control claims such as claim 23 and 5 cannot be infringed unless magnetic data storage invention claims such as claim 19 are also infringed. [Emphasis added by Defendant].

This mandatory inclusion of the automatic reset feature was necessary, so that Plaintiff could avoid a free license to the United States, since apparently the reset feature[4] is the only portion of the Sharpless-Eichert '813 patent disclosure occurring after Sharpless left the employ of the Government's contractor, under which employment the Government would be entitled to a royalty-free license.

With this background, Commissioner Davis held that "the" invention, "including the memory reset feature" was conceived after and outside of the employment of Sharpless by the Government's contractor. The full Court of Claims held that the United States "is fully licensed under claim 16, and is also licensed under all other claims of the Sharpless patent except to the extent that those other claims may be limited to the system's automatic reset feature explained below. We leave to later proceedings the determination of whether the three representative claims other than 16 (5, 19, 23) embrace the automatic reset feature, and if so, whether those claims (and the patent) as so construed are valid . . . . " (440 F. 2d at 1364).

4. And possibly the "store-if-no-exceed" feature.

The court has been advised that on the basis of the holdings of Commissioner Davis and of the Court of Claims that the Government would be liable for infringement of claims involving the automatic reset feature, the Government has paid Plaintiff a substantial sum in settlement.

Defendants have filed a motion for summary judgment holding claims 1–15 and 17–24 invalid under the second paragraph of 35 U.S.C. § 112 requiring that:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

Defendants contend that it was only when confronted with a licensing problem in the Court of Claims that Plaintiff took the position that the reset feature was asserted as vital to claims 1–15 and 17–24; and that had this been previously disclosed (as, it is argued, should have been done in the claims) it would have been easy to "design around" the reset feature. Defendants further argue that the reset feature is not essential to the functioning of Plaintiff's invention; and that if "reset" is required it can be effected mechanically, apart from Plaintiff's specification.

Particularly is the question of claim coverage of the reset feature important, since it is the only direct contribution of the so-called co-inventor Eichert (other than perhaps the "store-if-no-exceed" feature) and so a real question would be presented as to whether or not Sharpless and Eichert were co-inventors.

Defendants further point out that if the reset feature is, as Plaintiff asserts, "vital" to the validity of claims 1–15 and 17–24, then the earliest date of the invention is January 1948, which lets in the '827 patent, which patent Defendants assert (and are supported by their expert) teaches a system entirely responsive to the register selection recital of the claims of '813 patent in suit, but the '827 patent does not have a reset feature.

Defendants rely upon the well-established principle that "the claims made in the patent are the sole measure of the grant" Aro Manufacturing Co. v. Convertible Top Replacement Co., 365 U.S. 336, 339, 81 S.Ct. 599, 601, 5 L.Ed.2d 592 (1960); that the specification and drawings are simply exemplary; the true measure of the invention is defined by the claims. Reeves Instrument Corp. v. Beckman Instruments Inc., 444 F.2d 263, 274 (9 Cir. 1971); White v. Dunbar, 119 U.S. 47, 51, 7 S.Ct. 72, 30 L.Ed. 303 (1886);[5] Altoona Publix Theatres, Inc. v. American Tri-Ergon Corp., 294 U.S. 477, 55 S.Ct. 455, 79 L.Ed. 1005 (1934); Continental Paper Bag Co. v. Eastern Paper Bag Co., 210 U.S. 405, 409, 28 S.Ct. 748, 52 L.Ed. 1122 (1908); General Electric Co. v. Wabash Appliance Corp., 304 U.S. 364, 58 S.Ct. 899, 82 L.Ed. 1402 (1937).

[1] As stated in Waldon, Inc. v. Alexander Mfg. Co., 161 USPQ 404 (S.D. Miss.1969):

> "Any important aspect which is deemed important to an invention which is sought to be protected by a patent should be stated with such specificity as to afford a notice and warning to

5. The famous "nose of wax" case.

the public of its importance to the device as a protected portion of the patent. Vague generalities and nebulous and obscured phrases in the claim should never be extended by judicial construction."

Plaintiff relies on 35 U.S.C. § 112, paragraph 3 as a basis for finding the automatic reset feature in claims 1–15 and 17–24. That paragraph provides that:

"An element in a claim for a combination may be expressed as a means or step for performing a *specified function* without the recital of structure, material, or acts in support thereof, and such claim shall be construed to cover the *corresponding structure*, material, or acts *described in the specification* and equivalents thereof." [Emphasis supplied].

That the requirement of the second paragraph of Section 112 that the claim(s) particularly point out and distinctly claim the subject matter that the applicant regards as his invention has not been diminished by the third paragraph has been expressly held. Application of Lundberg, 244 F.2d 543, 547–548 (C.C.P.A.1957):

"The third paragraph of 35 U.S.C. § 112 made its initial appearance in the Patent Act of 1952. As correctly stated by appellants in their brief, this paragraph was designed, at least in part, to modify or overrule such decisions as Halliburton Oil Well Cementing Co. v. Walker, 1946, 329 U.S. 1, 67 S.Ct. 6, 10, 91 L.Ed. 3, and, as pointed out by an augmented Board of Appeals in Ex parte Ball & Hair, 99 USPQ 146 (Bd.App.1953), '* * * some measure of greater liberality in the use of functional expressions in the definition of elements in proper combination claims is authorized by section 112, than has been permitted by some of the stricter decisions of the courts in the past.' This 'measure of greater liberality,' however, is subject to well defined limitations, for Congress did not intend by incorporating the third paragraph into section 112, to destroy certain basic precepts of patent law. Thus, though appellants' arguments would necessarily lead to the opposite conclusion, it is still true that 'the claim is the measure of the invention.' The requirement in the second paragraph of section 112 that 'the specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention' has not been at all diminished by the addition of the third paragraph; the latter paragraph must be read in the light of the first and second paragraphs and given an interpretation consistent with their clear meaning . . . ." [Footnotes omitted].

The Patent Office Board of Appeals has also held that means plus function claims cover only the structure necessary to perform the specified function. Ex parte Birnbaum, 161 USPQ 635 (1968).

[2] Defendants vigorously and plausibly argue that the second paragraph of 35 U.S.C. § 112 requires a necessary or causal relationship between the "specified function" and apparatus purportedly included in such a "means" plus "specified function" claim recitation. Plaintiff's contention that there is no requirement of any "causal relationship" when the "statutory means for performing a specified function . . ." is used "because the function is all that is required to be specified and if, as here, that function is definite, that is sufficient to comply with 35 U.S.C. [§] 112 in its entirety," [6] is unsound.

The court suggests, and finds, that this is a logical fallacy if there is no "causal relationship." Otherwise, there would be no way for the public (or a court) reasonably to assess the asserted, or valid, scope of the claim language.

6. Plaintiff's "Response Under Protest to Defendants' Motion for Summary Judgment in Claims 1-15 and 17-24 on the Ground of Claim Indefiniteness," p. 8.

Plaintiff further asserts [7] that " 'Register selection' is a definite function so that claims 1–15 and 17–24 which recite the 'register selection' function are clearly definite."

If the claims reciting "register selection" had said, as they easily might (and should, and probably would, if that were intended) "in conjunction with the automatic reset function" there would be no room for argument that Plaintiff was right. The absence of such a recital, in the claims, or such an assertion in the prosecution in the Patent Office, militates strongly against such an interpolation.

With respect to Plaintiff's contention that the claims 1–15 and 17–24 do, and claim 16 does not, embody the "vital" automatic reset feature, it is necessary to consider the exact language of "representative" claims 5, 16, 19 and 23.[8]

Claim 5

"In an information storage system,

1. a central station,
2. a plurality of operating stations,
3. a transmission line extending from each of said operating stations to said central station,
4. a plurality of operating positions at each of said operating stations,
5. a plurality of registers at said central station adapted to receive numerical information and to have such information erased therefrom,
6. means under control of an operator at any one of said positions at any one of said stations for producing and sending over the line of said station a group of pulses indicative of a particular register and also containing numberical information which it is desired to store in that register,
7. means for preventing transmissions over the lines of the other stations during the operation at said one station,
8. means for preventing operations at the other positions of said one station during the operation at said one position,
9. means at said central station responsive to said pulses for selecting said register,
10. means operable upon selection of said register for indicating at said one position whether or not any number already stored in said register plus that to be stored exceeds a given number,
11. and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store."

Claim 19

"In an information storage system,

1. magnetic recording means having a plurality of information recording sections constituting registers and also having a register-selection section on which are recorded pulses coordinated with said registers,
2. means for producing from said recorded pulses different successively-occurring r_gister-selection voltage combinations representative respectively of said registers,
3. means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical infor-

7. Ibid. p. 8.

8. 440 F.2d at 1363, fn. 1. The numbered breakdown of the claims, made by Plaintiff in its "Statement of Position . . ." is adopted. For reasons which it is hoped will be readily apparent, claim 16 is quoted last.

mation which it is desired to store in that register,

4. means responsive to some of said pulses for producing a pattern of voltages,
5. means responsive coincidentally to said voltage combinations and said voltage pattern for selecting said register,
6. and means for storing said numerical information in said register."

Claim 23

"In an information storage system,

1. spot magnetization recording means including a plurality of registers adapted to receive numerical information and to have such information erased therefrom,
2. manually settable keyboard means at a remote position,
3. means operable cooperatively with said keyboard means to produce a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register,
4. means responsible to said pulses for selecting said register,
5. means operable upon selection of said register for indicating whether or not any number already stored in said register plus that to be stored exceeds a given number,
6. and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein by spot magnetization the sum of the erased number and the additional number which it is desired to store."

Claim 16

"A system for magnetic storage of a plurality of data respectively relating to different items of information,

1. comprising a magnetic member having a plurality of magnetizable data storage portions respectively assignable to said different items of information,
2. a magnetic recording and reading device adjacent to said magnetic storage member for selectively magnetizing any of said data storage portions for storing data thereon or alternatively for taking a reading of data previously stored thereon.
3. means for transmitting signals including item selection signals to said storage apparatus,
4. means for causing continuous relative rotation between said magnetic storage member and said magnetic recording and reading device for continuously scanning said plurality of data storage portions,
5. circuits separately operable through said magnetic recording and reading device for causing the device to record or read as desired,
6. selective means responsive to the received signals for rendering a desired one of said circuits operable,
7. and means including a gating circuit having space discharge tubes and whose timing is controlled by the received selection signals and the instantaneous position o' said recording and reading device relative to that of a data storage portion selected, thereby to effect a desired recording or reading operation." [9]

9. "The read-record timing invention was originally claimed in the application of Edwin L. Schmidt, filed May 5, 1948 and issued on February 26, 1952, as U.S. Patent No. 2,587,532 to The Teleregister Corporation, for a System for Magnetic Storage of Data. The read-record timing invention was the subject of an interference in the U.S. Patent Office between the Sharpless-Eichert patent application and the Schmidt patent application, and priority was awarded to Sharpless-Eichert . . . ." (Plaintiff's Position . . . . p. 11).

Plaintiff contends that the automatic reset feature is incorporated in claims 5, 19 and 23 by the "means" provisions of the following clauses:

Claim 5, clause 9:

"means at said central station responsive to said pulses for selecting said register . . . . ."

Claim 19, clause 5:

"means responsive coincidentally to said voltage combinations and said voltage pattern for selecting said register . . . . ."

Claim 23, clause 4:

"means responsive to said pulses for selecting said register . . . . ."

It is the "means" for "selecting said register" that are called for by each of said claims, and it is the "pulses" (Claims 5 and 23) or "voltage combinations and said voltage pattern for selecting said register" (Claim 19) that constitute those "means." Certainly no warning is given that these "means" involve or incorporate an automatic reset feature, any more than that they include keys, transmission and power lines, or signal lights. Such is also the uncontroverted testimony of Defendants' expert, Dr. McDuffie.[10]

Now compare the language of claim 16, which Plaintiff contends does not include the automatic reset feature, which Commissioner Davis says "may not" be included [11] and which was stated by the Court of Claims "was found by the commissioner and is agreed by the parties to be entirely independent of the reset device . . . . ." [12]

"2. a magnetic recording and reading device . . . for selectively magnetizing any of said data storage positions . . . alternatively for taking a reading of data previously stored thereon."

"5. circuits . . . for causing the device to . . . read as desired."

"6. selective means responsive to the received signals for rendering a desired one of said circuits operable."

If these do not relate to "register selection" the court's understanding of English is abysmally deficient. If these "means" do not include the automatic reset feature (as they do not in terms, and as Plaintiff asserts they do not) then it is difficult, if not impossible, to understand how representative claims 5, 19 and 23 do include such feature under the "means" language. "Means" apparently "means" only what Plaintiff "means" it to.

Some almost startling results follow.

If claim 16 does not incorporate the automatic reset feature under the "means" approach, claim 16 does not claim a "vital" element of "the" invention and accordingly is invalid.

If claim 16 does not incorporate the automatic reset feature under the "means" approach, but nevertheless *is* valid, then the automatic reset feature is not "vital" to the validity of the patent.

If claim 16 does in fact incorporate the automatic reset feature, despite Plaintiff's denial thereof, then it is impossible to give any intelligent interpretation to the claims of the patent.

If even the Plaintiff does not know what the claims mean, how can any businessman (or judge) find that they particularly point out and distinctly claim "the subject matter which the applicant

10. Attachment 7 to Defendants' Supporting Statement for Summary Judgment Motion, pars. 5, 6, 43–47.

11. 164 USPQ 57, fn. 7.

12. 440 F.2d at 1375.

regards as his invention"? (35 U.S.C. § 112, par. 2).

[3] In view of the foregoing, the court finds and holds that, because of Plaintiff's position as to the scope of the '813 patent and its "vital" elements, claims 1-15 and 17-24 are invalid, as not "particularly pointing out and distinctly claiming the subject matter which the applicant claims as his invention." (35 U.S.C. § 112, par. 2). Defendants' motion for summary judgment as to those claims is accordingly granted. For the reasons set forth above, the court *sua sponte* likewise grants summary judgment for the Defendants as to claim 16.

It thus becomes unnecessary to discuss the other contentions raised by Defendants, such as:

1. The automatic reset feature is useful only on initial start-up or in the event of a power failure; it is not necessary during continual operation.[13]

2. Other operational computers without reset features, such as ENIAC, EDVAC, UNIVAC and BINAC, were information and/or position volatile but these information-volatile devices were successfully used.[14]

3. With the January 1948 date for the '813 invention, the earliest possible if the automatic reset "vital" feature is accepted, '813 reads directly on the Eichert-Mauchly '827 patent which does not include a reset feature.[15]

4. That the register selection language of the '813 patent is sufficiently broad so that it would encompass equivalent systems directly driven from the revolving shaft of a mechanical system incapable of losing synchronization in the event of power failure.[16]

Judgment is hereby directed to be entered to the effect that claims 1-24 of the '813 patent are invalid.

13. McDuffie Affidavit, Attachment 7 to Defendants' Supporting Statement for Summary Judgment Motion, pars. 6-9, 32-33, 36-37.

14. Plaintiff's expert, Shaw, Court of Claims Transcript 3132-34.

15. McDuffie Affidavit, supra, pars. 39-42.

16. McDuffie Affidavit, supra, pars. 46-56.

UNITED STATES COURT OF APPEALS

THE FOURTH CIRCUIT

No. 75-1857

TECHNITROL, INC.

Plaintiff-Appellant

v.

CONTROL DATA CORPORATION

Defendant-Appellee

ORDER

No request for a poll of the court having been made, it is accordingly ADJUDGED and ORDERED that the petition for rehearing en banc shall be, and the same hereby is, denied.

The panel has considered the petition for rehearing and is of opinion it is without merit.

It is accordingly ADJUDGED and ORDERED that the petition for rehearing shall be, and the same hereby is, denied.

With the concurrences of Judge Winter and Judge Russell.

For the Court

Court of Claims of the United States

TECHNITROL, INC. v. UNITED STATES
No. 99-64 Decided Nov. 20, 1969

DAVIS, Commissioner.

This is a patent suit under 28 U.S.C. § 1498. Plaintiff seeks to recover "reasonable and entire compensation" for alleged unauthorized manufacture for and use by defendant of inventions described and claimed in U.S. Patent No. 2,611,813, entitled "Magnetic Data Storage System," issued to joint inventors T. K. Sharpless and E. S. Eichert, Jr., on September 23, 1952. Plaintiff Technitrol, Inc. (hereafter "Technitrol") is the record owner of the patent in suit (hereafter the "Sharpless patent"). Plaintiff's petition charges defendant with infringement of patent claims 1-4, 6-14, and 16-24.

On October 19, 1965, defendant filed a motion to dismiss or, in the alternative for partial summary judgment, on grounds that the United States is licensed under the Sharpless patent. On March 20, 1967, the court remanded the case to the trial commissioner with instructions to find facts relevant to the license issue. Thus, at this time, only the license issue is before the court. Issues of patent validity, infringement, and accounting are deferred to later proceedings, if necessary.[1]

[1] Trial on the license issue generated 3,457 pages of transcript, 300 pages of briefs, and 500 pages of proposed findings of fact and objections thereto. Though both parties in their briefs and proposed findings raised some patentability questions, they are not within the scope of the court's order of March 20, 1967, and are left open.

For reasons hereafter discussed, we hold that defendant is not licensed under the Sharpless patent.

Patent in suit

The Sharpless patent relates to electronic computers[2] and particularly "to systems for storing information, especially where it is desired to transmit, receive and record information." A particular use noted in the patent specification is "to store information concerning reservations on public carriers such as airplane lines, railway lines, etc." Generally, the system described in the patent comprises (1) a central storage unit which stores on magnetic disks information, such as the number of seats available and reserved on various flights of a commercial airline, and (2) remote operating stations, such as airline reservations desks at airports or hotels, where an operator through a suitable keyboard can request information of and send information to the central unit. The system is designed to permit an operator at a remote station to find out from the central storage unit whether seats are available on a particular flight; and if so, to record additional reservations up to the limit of the flight's capacity.

The system is described in detail in the findings of fact and is here summarized as follows. The central storage unit consists of a number of magnetic disks (information disks) mounted on a common shaft for rotation by an electric motor. Information, such as the number of seats already reserved and the number of seats available, is stored on the disks in the form of discrete areas of magnetization, called magnetic pulses. The pulses are arranged circumferentially in groups, called registers, around the faces of the disks. Each register contains information about a particular airline flight. Magnetic pickup heads are mounted adjacent the disks so that as the disks rotate, the heads through appropriate circuitry can "read" pulses on the disks, "write" new pulses on the disks, or "erase" existing pulses.

The remote stations are connected to the central storage unit through electrical transmission lines, akin to ordinary telephone lines. Each remote station has three keyboards, presumably one for each of three airline reservations clerks. By setting appropriate punch keys, an operator can designate (a) a particular flight on a particular day about which he desires information and (b) the number of seat reservations needed. In essence, the punched keys, through appropriate circuitry and coding, set up electrical pulse signals which are transmitted to the central station. At the central station, the signal is decoded and split. The portion of the signal representing the number of seat reservations desired is sent to an electronic adder. The portion of the signal representing the particular flight actuates circuitry for locating the proper register on the information disks. Having located such register, the information thereon, i.e., the number of seats already reserved, is sent to the adder. The adder then sums the "seats desired" and the "seats already reserved." If the sum exceeds the number of seats available, an alarm circuit lights up a lamp at the remote station, so-indicating. If the sum does not exceed the number of seats available, then the register is erased, the new sum is recorded thereon, and the remote station is so-advised, indicating that the reservation has been accepted. The system is then ready for another sequence of operations on demand from a remote station. All this takes about 0.14 seconds.

The system is designed so that, through appropriate scanning and selector equipment, only one keyboard of any remote station can communicate with the central station at a time. This avoids the possibility of simultaneous duplicate requests being made to a register from more than one keyboard, and thus prevents a particular flight from being oversubscribed.

A particular aspect of the invention, significant to the license dispute here in issue, relates to the so-called memory reset feature by which position volatility of the system is avoided. To explain, on the common shaft with the information disks is a master or clock disk which has recorded around its face two channels of magnetic pulses—one channel has 160 evenly-spaced pulses, the other 1 pulse. The purpose of the clock disk, as its name implies, is to serve as a timing device to coordinate the timed-position of the information disks with other elements and circuits of the computer system. A pickup head is located over each channel. Thus, one head produces 160 evenly-timed pulses per revolution of the clock disk, the other one pulse per revolution. The 160-pulse head is connected to a scale-of-ten electronic counter which produces one output signal for each 10 input pulses. Thus, the counter generates 16 pulses (160/10) for each revolution of the clock disk, and it thereby divides the infor-

[2] For those uninitiated in the language of the computer art, a glossary of terms, helpful to understanding this opinion, is set out in finding 5.

mation disks (on a common shaft with the clock disk) into 16 10-pulse registers, or information segments. Pulses from the scale-of-ten counter are applied through electronic circuitry to a digital counter which in turn produces 16 unique voltage combinations, each thus representative of one register on an information disk. When one of the voltage combinations matches up with, or coincides with, a similar combination from a remote station (generated by an operator seeking information about a particular flight, or register), circuitry is activated by which the register is read.

It can be seen from the above that it is essential for the clock disk and the scale-of-ten counter to stay in synchronization. Otherwise, the counter will not produce signals representative of each register; or, to say it another way, the system would be position volatile. During normal operation, with power on and the equipment functioning properly, the clock disk and counter will stay synchronized. However, at startup initially, or after a power failure, the clock disk and counter may lose synchronization, e.g., if the clock disk continues rotation momentarily through inertia after electric power is cut off the counter and the motor. Also, when power is cut off, the counter, a purely electronic device, loses count; and on restart, its counts may not be synchronized with the start of a register on an information disk so that such counts would be arbitrary with respect to register positions. Thus, some means must be provided to synchronize the clock disk and counter on startup. The one pulse per revolution channel on the clock disk serves that purpose. It is connected through appropriate circuitry to reset the counters to zero after each revolution of the clock disk, thereby synchronizing the clock disk and counter if they are out of synchronization.

The 24 patent claims are combination claims which define the invention in terms of the elements making up the system. They are of varying scope, in general describing the magnetic memory central storage device, the remote stations, and associated circuitry by which the system is made operable. Claim 16 differs from the other claims in that it does not recite the remote stations and is directed primarily to details of the central station. It originated in a patent application with which the Sharpless application was in interference in the U. S. Patent Office. Priority of the subject matter of claim 16 was ultimately awarded to Sharpless and Eckert after an amicable settlement agreement.

The clock disk and associated counters are not expressly recited in any of the claims. Rather they are included in claims 1-15 and 17-24 in broad "means" clauses which define the register-selection part of the system. Claim 19 is representative, the pertinent clause stating, "• • • means for producing from said recorded pulses [on the clock disk] different successively-occurring register-selection voltage combinations representative respectively of said registers • • •"

Defendant contends it is licensed under the Sharpless patent by virtue of a government-sponsored research and development contract with the University of Pennsylvania (the EDVAC contract) under which Sharpless worked. By way of background, the U.S. Army in the early 1940's sought to develop an electronic computer capable of solving mathematical problems relating to ballistics studies. Analog computers used to date were not satisfactory. On June 5, 1943, the Army entered a contract with the University of Pennsylvania (Moore School of Electrical Engineering) to "engage in research and experimental work in connection with the development of an electronic numerical integrator and computer," later to become known as the ENIAC, the world's first general-purpose digital computer. The University agreed to prepare a report of work done under the contract and to deliver to the Government any equipment developed. The University also agreed to grant a license to the Government to "all inventions and/or discoveries made and/or reduced to practice in the execution of this contract, whether patented or unpatented." Ultimately, the ENIAC was built and delivered to the Army's Aberdeen Proving Ground, Maryland, in late 1946. It was designed for parallel, multiple channel operation to solve various mathematic problems, particularly differential equations. Its input and output devices were punchcard equipment. Its memory elements, arithmetic elements, and control elements consisted of vacuum tubes and associated circuitry. Programming was done by manually setting up the equipment prior to performing computing operations. Although the ENIAC was a general-purpose computer, its capability and versatility were limited by small internal storage capacity and somewhat clumsy programming techniques. The ENIAC is the subject of U. S. Patent No. 3,120,606, under which the United States is licensed pursuant to the above-noted contract.

On October 28, 1944, while work was progressing on the ENIAC, the contract was amended to include in its scope-of-work provision, "research and experimental work in connection with the development of an

Electronic Discrete Variable Calculator" (EDVAC). As set out in a 110-page report (hereafter "EDVAC report") later prepared for the Government by J. Presper Eckert, Jr., and John W. Mauchly, co-inventors of the ENIAC, the EDVAC was to be a second-generation electronic computer, intended as an improvement over the ENIAC. It was to have a high-speed memory capacity for storing numbers, such as mathematical function tables; its arithmetic equipment was to have near-immediate access to the memory unit; its input and output equipment was to be magnetic tape, rather than punchcards; and it was to operate on stored information serially, rather than in parallel. The EDVAC report noted: "The EDVAC and the ENIAC have very little in common. Although they are both electronic digital computing machines, the resemblance ends there."

A principal feature of the EDVAC was its memory unit, which was to store not only information, such as numbers, but also program instructions by which the stored information was to be manipulated. The report noted that magnetic storage and memory devices were disclosed in January 1944 and provided one way to store information. However, it was contemplated that the EDVAC would use an "acoustic delay line memory device", invented by Eckert and Mauchly in early 1944, which "provided a way of obtaining large high-speed storage capacity with comparatively little equipment." Though much development work was needed to perfect the delay line device, it was deemed appropriate for the EDVAC.

On April 12, 1946, the Army entered a second contract (EDVAC contract) with the University of Pennsylvania to "design and develop a preliminary model of a small Electronic Discrete Variable Calculator • • • that will demonstrate the feasibility of producing subsequently an EDVAC having comprehensive properties envisioned in the • • • [EDVAC report]." Thus, the EDVAC project, initiated under the ENIAC contract, was now the subject of a separate contract. As in the ENIAC contract, the University further agreed to grant licenses to the Government to inventions made in the performance of the contract. As work progressed on the EDVAC model, the EDVAC contract was amended from time to time. On February 10, 1947, the contractor agreed to include in the model four "additional features," each of which made more specific the details of construction of the model. (Finding 12(a).) On September 24, 1947, the contractor agreed to include six more features, further limiting the device. (Finding 12(b).) Finally, on April 30, 1948, the contract was amended to call for a full-scale EDVAC to achieve completely the objectives set out in the EDVAC report. (Finding 12(c).) In 1949, the completed EDVAC was delivered to the Government. U. S. Patent No. 2,629,827, which describes and claims various features of the EDVAC, particularly the acoustic delay line memory, ultimately issued in 1953. The Government was granted a license under the patent.

Sharpless, one inventor of the patent in suit, worked on both the ENIAC and EDVAC projects at the University of Pennsylvania. He was employed by the Moore School in 1943 and worked as a research engineer on the ENIAC until its completion in 1946. From April 1, 1946 until he left the Moore School on October 1, 1947, he was supervisor of, first, the ENIAC project, then the EDVAC project. Eichert, the co-inventor of the patent in suit, worked at the Moore School from July 1945 to April 1947. He did not, however, work on either the ENIAC or EDVAC projects.

Plaintiff Technitrol was incorporated on April 15, 1947, by Sharpless, Eichert and two others, to exploit the technology of high-speed computers in military and industrial fields. Technitrol started business on May 1, 1947, its first contract being for development of a small, inexpensive radar unit for tugboats and pleasure craft. Later, in 1947, it got contracts to develop a mercury delay line memory unit for electronic computers and an automatic cash registry system for supermarkets. Though still employed by the Moore School in the summer and early fall of 1947, Sharpless worked for Technitrol on occasional evenings and during the 2-week summer recess at the Moore School. Though the evidence is not entirely clear, it appears that the University knew and acquiesced in Sharpless' part-time, off-duty work for Technitrol.

In the summer of 1947, Technitrol personnel, including Sharpless, were approached about developing a computerized airlines reservations system for American Airlines. After a meeting with American representatives on August 4, 1947, Sharpless the next day submitted a report to Technitrol management recommending that Technitrol develop a system at its expense since American refused to underwrite development costs. In his report, Sharpless noted that the key element was a memory system of sufficient capacity to store extensive reservation information (880 flights per day, 31 days a month) and sufficiently fast to provide res-

ervation information in 2 or 3 seconds. A magnetic storage device was particularly suitable.

In early August 1947, Technitrol opened Job No. 107 to develop an airlines reservations system, called "Reservisor." During mid-August, Sharpless prepared several sketches describing a proposed system. (Finding 20.) After October 1, 1947 when Sharpless left the Moore School to devote full time to Technitrol activities, he continued working on the "Reservisor" system. (Finding 21.) In December 1947, Eichert joined Sharpless full-time on the project. Eichert had left the Moore School in April 1947 to join Technitrol and had helped Sharpless from time to time during the summer by reviewing drawings and offering advice and criticism.

To show progress on the "Reservisor" project up to January 1, 1948, Sharpless prepared a drawing of the system as then envisioned. (Finding 23.) The central storage unit consisted of, among other things, information disks and a clock disk mounted on a common shaft, above described; however, the clock disk did not have the one pulse per revolution channel by which the memory could be reset to avoid position volatility. Recognizing the problem, Eichert, sometime after January 1, 1948, suggested modifying the clock disk with the single-pulse channel.

On April 14, 1948, the memory unit for "Reservisor" was successfully operated. Keyboards at remote stations for producing signals were simulated. On May 21, 1948, a system including remote keyboards was successfully operated. On May 26, 1948, a patent application which matured into the patent in suit was filed, naming Sharpless and Eichert as joint inventors. On June 14, 1948, the system was demonstrated to representatives of American Airlines.

The license defense

Against this factual backdrop, defendant contends that the invention in suit was "conceived * * * in the performance of * * * [the EDVAC] contract,"[3] within the meaning of that contract's patent clause. Defendant concedes that Eichert never worked on the EDVAC (or ENIAC) projects; but it contends that Sharpless' work during the summer of 1947 constituted "conception" of the invention and was "in the performance of" the EDVAC contract. Principal reasons for defendant's position are that "there was a close and inseparable relationship between the claimed invention in the Sharpless et al. patent and the EDVAC research and development work authorized under the contract"; that the Sharpless and Eichert invention relates to "subject matter, scope and goals of the EDVAC project" since "all fall into the area of electronic digital computation and data processing"; and that "Sharpless would not have been capable of making the circuits or combinations of circuits of the Sharpless et al. patent except for the knowledge and experience he gained on the EDVAC contract." Plaintiff, on the other hand, contends that the invention in suit, as defined by the patent claims, was not "conceived" until Eichert solved the problem of position volatility, i.e., after January 1, 1948, a time when neither Sharpless nor Eichert were associated with the University of Pennsylvania; that therefore the University, and hence the Government, has no license rights under the patent in suit; and, in any event, whatever work Sharpless did toward development of the invention while he was still employed by the University was initiated, financed and directed by Technitrol and was not "in the performance of" the EDVAC contract. The issues, then, come down to (1) what is the invention in suit, (2) when was it "conceived," and (3) was it conceived "in the performance of" the EDVAC contract.

[1] It is the patent claims which define the legally protected subject matter of a patent. Continental Paper Bag Co. v. Eastern Paper Bag Co., 210 U.S. 405, 409 (1908); White v. Dunbar, 119 U.S. 47, 51 (1886).

[2] The specification and drawings describe the invention to those skilled in the art and may be looked to in construing and understanding the scope of the claims. Smith v. Snow, 294 U.S. 1, 24 USPQ 26 (1935). Defendant's contention of license is bottomed on its interpretation of the claims as not including the memory reset feature, i.e., the two-channel clock disk and associated counters. According to defendant, this feature is not expressly recited in the claims, thus forms no part of the legally protected subject matter of the patent. Plaintiff concedes the memory reset feature is not expressly recited, but says the "means" clauses, above noted, directed to the register-selection part of the system include the two-channel clock disk. We agree with plaintiff. "Means" clauses are expressly permitted by the patent statute, 35 U.S.C. § 112, which says that an "element in a claim for a combination may be expressed as a means * * * for performing a specified function without the recital of structure * * * in support thereof, and such claim shall be construed to cover the corresponding structure * * * described in the specification and equivalents thereof." Ellicon Mach. Co. v. United States, 186 Ct. Cl. 655, 644-5, 405 F.2d 1385, 1390, 160 USPQ 753 (1969); Stearns v. Tinker & Rasor, 252 F.2d 589, 597, 116 USPQ 222, 228 (9th Cir. 1957). The register-selection function of the claimed system is performed, in part, by the two-channel clock disk which is "corresponding structure described in the specification" within the meaning of the statute.[4]

Defendant also says the specification and drawings do not support the claims as above construed because the drawing does not show a direct connection between the one pulse per revolution channel of the clock disk and the counters which it resets. This argument is groundless. The specification teaches that the "one pulse per revolution output supplied from the clock disk * * * is used to initially set the counters so that the registers on the disks will always maintain the same relation with the pulses on the clock disk *as checked by counters* b [scale-of-ten counter] and c [binary counter] * * *." (Emphasis added.) In conjunction with Fig. 4 of the patent drawing, which illustrates diagrammatically the clock disk, information disks, counters, and associated circuitry, the disclosure is adequate to teach one skilled in the art how to practice the invention. See Anthony Co. v. Perfection Steel Body Co., 315 F.2d 138, 140, 137 USPQ 186, 188 (6th Cir. 1963).

Having construed the claims, the issue then is when the claimed subject matter was "conceived." Conception in the patent law is defined in 1 Walker, Patents § 45 (Deller's 2d ed.) at 191-2, as

> * * * the formation in the mind of the inventor of a definite idea of a complete and operative invention as it is thereafter to be reduced to practice * * *
>
> The date of conception is the date when the inventive idea is crystallized in all of its essential attributes and becomes so clearly defined in the mind of the inventor as to be capable of being converted to reality and reduced to practice by the inventor or by one skilled in the art.

The record is clear that while Sharpless did considerable preliminary design work on the reservations system in mid-1947, it was not until early 1948, when working full time

[3] Plaintiff will, of course, be bound in further proceedings on validity and infringement by the claim construction here held. See Dominion Magnesium Ltd. v. United States, 162 Ct. Cl. 240, 320 F.2d 388, 138 USPQ 306 (1963).

for Technitrol, that the problem of position volatility was recognized and solved by Eichert. Only then was there a complete system, as envisioned by the inventors and later disclosed in their patent application. Defendant makes much of the fact that a position volatile system is nevertheless operable in a legal sense because the problem of position volatility only arises at initial start-up and startup after a power failure. Thus, defendant reasons, there was conception of the invention in suit before the position volatility problem was recognized and solved. In our view, however, while there may have been conception of *an* invention before Eichert came on the scene, it was not *the* invention disclosed and claimed in claims 1-15 and 17-24 of the patent in suit. The Sharpless and Eichert invention included the memory reset feature and it is *that* invention with which we are here concerned.[5] Eichert never worked under the EDVAC contract; and by 1948, Sharpless had no connection with the EDVAC project or the University of Pennsylvania. We hold, therefore, that the invention in suit was not conceived under the EDVAC contract.

Aside from the question of when the invention in suit was conceived, we further hold that defendant is not entitled to a license for the simple reason that the invention was not made "in the performance of" the EDVAC contract. The EDVAC contract contemplated from the outset development of a high-speed general purpose computer, a principal feature of which was an acoustical delay line memory device. The Sharpless and Eichert system, on the other hand, was designed from the beginning to be a fixed-program system for inventory control with comparatively slow magnetic memory. The impetus for its development came from American Airlines, not the Government. And, though Sharpless concededly made some sketches and did preliminary design work while employed by the University and working on the EDVAC, the work was done while he was in a University-approved consulting capacity to Technitrol, and was

[4] This is not meant to imply that, but for solution to the problem of position volatility, Sharpless conceived the reservations system in mid-1947 while employed by the University. There is doubt on this record whether in any event such a system was conceived before late 1947, after Sharpless left the University. We need not resolve this point, however, in view of the way the specification and claims are here construed.

paid for by Technitrol. Nothing in the record suggests that he used University or government facilities or funds in developing the reservations system.[7]

Defendant relies heavily on Mine Safety Appliances Co. & United Tanks, Inc. v. United States, 176 Ct. Cl. 777, 364 F.2d 385, 150 USPQ 453 (1966), a case in which this court held the Government to be licensed under a patent for crash helmets. In Mine Safety, the Government entered a contract for research on the effects of acceleration on the human body, particularly on pilots in high-speed aircraft. During performance of that contract, employees of the contractor developed a crash helmet, the design and purpose of which flowed directly from the research project. In holding that the Government was licensed under a patent covering the crash helmet, the court noted, among other things, that the contract parties anticipated development of protective gear as part of the contract work; that work on the helmet was done (both in place and time) close to the acceleration studies; and that post-contract statements by the contractor showed an intention that the crash-helmet development was to be within the scope of the contract.

Unlike Mine Safety, there is nothing in this case to suggest the Government was in any way interested in development of a reservations system, or even an inventory control system, with a central magnetic storage unit and remote operating stations. And while the EDVAC project and the reservations system involved some common problems of technology in a fledgling art, they were aimed at different goals, used significantly different means, and required considerable independent development. There was not between the two projects "a close and umbilical connection" as existed in Mine Safety (at 787).

Finally, a word about claim 16. Defendant correctly states that during the Patent Office interference proceeding, noted above, Sharpless and Eichert, through counsel, alleged in their preliminary statement that the claim's subject matter was first "disclosed to others during * * * July, 1947", and was first shown in a "drawing * * * made during * * * August, 1947." Later, in litigation of the patent in suit in the District Court for the Northern District of New York, a similar statement was made during discovery in answer to queries about the earliest date of invention upon which Technitrol would rely and seek to prove. Defendant says plaintiff has thereby admitted that the claimed subject matter was made during performance of the EDVAC contract because Sharpless was employed by the Moore School and working on the EDVAC project in mid-1947. Plaintiff, however, argues that the statements asserted in the interference and litigation were mere allegations, not proven facts, and do not constitute admissions. It is unnecessary to resolve this dispute.[8] For reasons already discussed, the subject matter of claim 16, as well as the other claims, was not made "in the performance of" the EDVAC contract. Plaintiff's allegations of Sharpless' activities in July and August 1947 may be pertinent to issues of validity and infringement of claim 16, but those issues are not now before the court.[9]

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[7] There is conflicting and unclear testimony regarding Sharpless' relationship to the University vis-à-vis Technitrol during the summer of 1947. Particularly pertinent, however, is the University's answer to a complaint filed by Technitrol in a Pennsylvania state court to quiet title to the patent in suit. In its answer, dated August 2, 1966, the University admitted that "Sharpless was given permission by his superior to act in a consulting capacity for Technitrol from May 1, 1947 to September 30, 1947."

[8] We note in passing, however, that plaintiff is correct that the alleged "facts" were never proved. The interference was settled before resolving the issue whether the subject matter of claim 16 was conceived in July-August 1947. As for the New York litigation, there is nothing in this record to show what facts plaintiff established, if any. See Dewey v. Lawton, 347 F.2d 629, 146 USPQ 187 (CCPA 1965).

[9] For example, if the subject matter of claim 16 was conceived by Sharpless in mid-1947, Eichert is not a joint inventor, 35 U.S.C. § 116. Also, claim 16 may not include in its scope the memory reset feature which came up in 1948 when Eichert was working on the reservations system project. Resolution of these and other validity and infringement problems must await further proceedings.

440 F.2d 1362

TECHNITROL, INC.
v.
The UNITED STATES.
No. 99-64.

United States Court of Claims.
April 16, 1971.

Before COWEN, Chief Judge, and LARAMORE, DURFEE, DAVIS, COLLINS, SKELTON, and NICHOLS, Judges.

OPINION

DAVIS, Judge.

This is a patent suit under 28 U.S.C. § 1498 in which plaintiff seeks "reasonable and entire compensation" for alleged unauthorized manufacture for and use by the Federal Government of inventions described and claimed in U. S. Patent No. 2,611,813, entitled "Magnetic Data Storage System", issued to joint inventors T. K. Sharpless and E. S. Eckert, Jr. in 1952. Plaintiff Technitrol, Inc. is the record owner of this patent—the Sharpless patent. Plaintiff's petition charges infringement of claims 1–4, 6–14, and 16–24.[1]

[1] The parties have agreed that four claims (5, 16, 19, 23) are representative of the claimed subject matter of the patent, and therefore that the scope of the patent can be determined by reference to those claims.

Believing that it is free to use the patented invention, defendant moved to dismiss or, in the alternative for partial summary judgment, on the ground that the United States is licensed under the Sharpless patent. Plaintiff then countermoved for partial summary judgment that the United States is not so licensed, or for an order specifying the facts not in controversy on that issue. Without resolving the question, the court remanded the case to the trial commissioner with instructions to find the facts relevant to this license issue. The case is now before us on the commissioner's report on that question.[2]

[1] For the reasons which follow we hold that the defendant is fully licensed under claim 16, and is also licensed under all other claims of the Sharpless patent except to the extent that those other claims may be limited to the system's automatic reset feature, explained below. We leave to later proceedings the determination of whether the three representative claims other than 16 (5, 19, 23) embrace the automatic reset feature, and if so whether those claims (and the patent) as so construed are valid. If both questions are answered affirmatively, then the issue of infringement will have to be reached as to those and the remaining claims.

The Sharpless patent

The Sharpless patent, relating to electronic computers,[3] discloses a magnetic data storage system, and has particular application "to systems for storing information, especially where it is desired to transmit, receive, and record information". The specification notes that a particular use of the system is "to store information concerning reservations on public carriers such as airplane lines, railway lines, etc." Generally, the system described in the patent comprises (1) a central storage unit which stores on magnetic disks information such as the number of seats available and reserved on various flights of a commercial airline; (2) remote operating stations, such as airline reservation desks at airports or hotels, where an operator through a suitable keyboard can request information of and send information to the central unit; (3) an arithmetic adding unit, for calculating information to be placed into the central storage unit; and (4) a control unit for sequencing various operations performed by the system. The system is designed to permit an operator at a remote station to find out from the central storage unit whether seats are available on a certain flight, and, if so, to record additional reservations up to the limit of the flight's capacity.

A detailed description of the system is contained in the findings of fact, but the salient technical characteristics may be summarized as follows: The central storage unit consists of a number of magnetic disks (information disks) mounted on a common shaft for rotation by an electric motor. Information, such as the number of seats already reserved and the number of seats available, is stored on the disks in the form of discrete areas of magnetization, called magnetic pulses. The pulses are arranged circumferentially in groups, called registers, around the faces of the disks. Each register contains information about a particular airline flight. Magnetic pickup heads are mounted adjacent to the disks so that, as the disks rotate, the heads, through appropriate circuitry, can "read" pulses on the disks, "write" new pulses on the disks, or "erase" existing pulses.

The remote stations are connected to the central storage unit through electrical transmission lines, akin to ordinary telephone lines. Each remote station has three keyboards, presumably one for each of three airline reservation clerks. By setting appropriate punch keys, an operator can designate (a) a particular flight on a particular day about which he desires information and (b) the number of seat reservations needed. In essence, the punched keys, through the necessary circuitry and coding, set off electrical pulse signals which are transmitted to the central station. There, the signal is decoded and split. The portion of the signal representing the number of desired seat reservations is sent to an electronic adder. The portion of the signal representing the particular flight actuates circuitry for locating the proper register on the information disks. When that register is located, the information on it, *i. e.*, the number of seats already reserved, is sent to the adder. The adder then sums the "seats desired" and the "seats already reserved". If the total exceeds the number of seats available, an alarm circuit lights up a lamp at the remote station, so indicating. If the sum does not exceed the number of seats available, then the register is erased, the new sum is recorded, and the remote station is so advised, indicating that the reservation has been accepted. The system is then ready for another sequence of operations on demand from a remote station. The entire process takes about 0.14 seconds.

The system is designed so that, through its scanning and selector equipment, only one keyboard of any remote station can communicate with the central station at a time. This feature avoids the possibility of simultaneous duplicate requests being made to a register from more than one keyboard, and thus prevents a particular flight from oversubscription.

A particular aspect of the Sharpless system, as alleged by plaintiff,[4] is the automatic or memory reset feature by which position volatility is avoided. On the common shaft with the information disks is a master or clock disk which has recorded circumferentially about its face two channels of magnetic pulses, one channel has 160 evenly-spaced pulses, the other has one pulse. The purpose of the clock disk, as its name implies, is to serve as a timing device to coordinate the timed-position of the information disks with other elements and circuits of the computer system. A pickup head is located over each channel. One head produces 160 evenly-timed pulses per revolution of the clock disk, the other one pulse per revolution. The 160-pulse head is connected to a scale-of-ten electronic counter which produces one output signal for each 10 input pulses. The counter therefore generates 16 pulses (160/10) for each revolution of the clock disk, and it thereby divides the information disks into 16 10-pulse registers, or information segments. Pulses from the scale-of-ten counter are applied through electronic circuitry to a digital counter which in turn produces 16 unique voltage combinations, each thus representative of one register on an information disk. When one of the voltage combinations matches up, or coincides, with a similar combination from a remote station (generated by an operator seeking information about a particular flight or register), circuitry is activated by which the register is "read".

It is essential that the clock disk and the scale-of-ten counter stay in synchronization. Otherwise, the counter will not produce signals representative of each register, or, to put it another and more technical way, the system would be position volatile. During normal operation, with power on and the equipment functioning properly, the clock disk and coun-

2. We are obligated to Commissioner James F. Davis for his opinion, parts of which we incorporate although we reach a different result, and for his findings of fact. Defendant takes numerous exceptions to those findings, exceptions which are practically all opposed by plaintiff. We have endeavored to resolve these conflicts only as to those factual areas material to our disposition of the limited issue now before us. Our findings in those areas (and in areas in which no substantial controversy between the parties exists) are marked by an asterisk, and are intended as conclusive determinations of the matters contained therein for the whole of this litigation. Other findings, not marked by an asterisk, are adopted solely for the purposes of this opinion; the parties are free to attack or to support them in subsequent proceedings.

3. For those uninitiated in the computer art, a glossary of terms, helpful for understanding this opinion, is set out in finding 5.

4. Defendant denies that any of the claims in suit covers this automatic or memory reset feature.

ter will stay synchronized. However, at start-up, either initially or after a power failure, the clock disk and counter may lose synchronization. For example, the clock disk may continue to rotate momentarily, through inertia, after electric power to the counter and the motor have ceased. Also, when power is cut off, the counter, a purely electronic device, loses count; and on re-start, its counts may not be synchronized with the start of a register on an information disk, so that such counts would be arbitrary with respect to register positions. Plaintiff asserts that this problem of potential loss of synchronization, or position volatility, is solved by the one pulse per revolution channel of the clock disk, which, it contends, is disclosed in the patent as connected through appropriate circuitry to reset the counters to zero after each revolution of the clock disk, thereby synchronizing the clock disk and counter if they are out of synchronization.

The 24 patent claims are combination claims which define the invention in terms of the elements making up the system. In general, they describe the magnetic memory central storage device, the remote stations, and associated circuitry by which the system is made operable. Claim 16 differs from the other claims in that it does not recite the remote stations and is directed primarily to details of the central station.

The Government's computer contracts with the University of Pennsylvania (ENIAC and EDVAC)

Defendant contends that it is licensed under the Sharpless patent because the invention claimed was developed in the course of government-sponsored research at the Moore School of Electrical Engineering of the University of Pennsylvania.

Mr. T. K. Sharpless graduated from the Moore School with a bachelor's degree in electrical engineering, and was thereafter hired by the Research Division of the Moore School in February 1943 as a full-time, non-academic, professional engineer to work on outside contracts negotiated with the School, which consisted preponderantly of those with the United States. In the early 1940's, the Army was interested in developing an electronic computer with a broad capability of solving mathematical problems relating to ballistic studies. Analog computers used for this purpose had proven unsatisfactory. So, after consultation with the Moore School, the Army in 1943 decided to underwrite the creation of the world's first general purpose electronic digital data processor or computer. At that time, digital computer technology was a virgin and unexplored universe charted only by untested theories unaccompanied by much practical experience. The research and development contract which the United States made with the University of Pennsylvania therefore called broadly for the Moore School "to engage in research and experimental work in connection with the development of an electronic numerical integrator and computer", later to become known (from its initial letters) as the ENIAC. The Government specified the capabilities it desired in the completed machine—what the ENIAC was supposed to be able to do—but it did not otherwise limit the scope or direct the path of the research to be conducted. In particular, the United States did not suggest a mode of operation, the speed of calculation, or the type of circuitry to be used; indeed, the Government was not in a position to furnish guidance in any of these areas. The ENIAC contract, in short, represented a first broad-scale foray into the digital computer field, and no one knew for certain what would be encountered. Sharpless was a key research engineer on the ENIAC project and played an important role in the overall planning of the contract performance. The ENIAC program ultimately produced a patented machine [5] to which the Government received a nonexclusive license under the contract.[6]

5. U. S. Patent No. 3,120,606, filed in June 1947 by joint inventors John W. Mauchly and J. Presper Eckert.

After starting work on the ENIAC, the Research Division of the Moore School came to believe that a new machine, using techniques of operation and circuitry different from those contemplated for the ENIAC, could be built which would better perform the tasks desired by the Army. In October 1944, the scope of the ENIAC contract was broadened to include "research and experimental work in connection with the development of an Electronic Discrete Variable Calculator", or EDVAC (following the initial letters of the name). Work on the EDVAC was performed concurrently with that on the ENIAC until the completion of the ENIAC contract. In April 1946 the Army entered into a second contract with the University of Pennsylvania; this one called for full-scale research and development of an EDVAC.

Sharpless, who had previously worked on the EDVAC under the ENIAC contract, became technical director of the EDVAC project. He remained on the Moore School's payroll through October 15, 1947.[7] Eickert, the co-inventor of the Sharpless patent, worked at the Moore School from September 1945 to April 1947, but did not participate in either the ENIAC or EDVAC projects.

Technitrol, Inc.

In April 1947, Sharpless, Eickert, and two other persons, incorporated plaintiff Technitrol, Inc. to exploit the technology of high speed computers in the military and industrial fileds. Although still employed by the Moore School in the summer and fall of 1947, Sharpless worked for Technitrol on occasional evenings and during the two-week summer recess at the School.[8]

6. The ENIAC agreement contained the following patent rights clause:
"*Devices Embodying Inventions and/or Discoveries.* The Contractor [the University of Pennsylvania] agrees, as part of the consideration, and without any further cost to the Government to grant to the Government an irrevocable, nonexclusive, royalty-free right and license to make, use, and sell and cause to be made, used, and sold, for any purpose, devices, materials and processes utilizing any and all inventions and/or discoveries made and/or reduced to practice in the execution of this contract, whether patented or unpatented. The Contractor agrees to make to the Government, prior to final settlement under this contract, a complete disclosure of all inventions or discoveries under this contract, a complete disclosure of all inventions or discoveries made and/or developed during the performance of this contract and to grant a power to inspect the papers involved in the prosecution of applications for letters patent on those of the said inventions or discoveries which have been or will be covered by applications for patents filed or caused to be filed by the Contractor. As to all such inventions or discoveries that are not covered or to be covered by applications for patents filed by the Contractor, the Contractor agrees that the Government shall have the right to file, prosecute, and act upon applications for patents thereon; that the Contractor will secure the execution of the necessary papers and do all things requisite to protect the Government's interest in prosecuting such applications to a final issue."

7. The parties dispute whether Sharpless left the Moore School on September 30th or October 15th. We do not consider this difference very important, but on the weight of the evidence we determine that October 15th is the more probable date.

8. Whether Sharpless was authorized by the University to "moonlight" for Technitrol during this period is hotly contested. Defendant offered the testimony of Dr. Travis, Sharpless' supervisor at the Moore School, who stated that clear University policy forbade outside employment by non-academic personnel, and that he did not recall being asked to make, or making, an exception for Sharpless' benefit. Plaintiff relied on a pleading by the University in a separate private action which said that Sharpless had been given permission to act in a consulting capacity for Technitrol (the pleading did not specify the areas in which he was permitted to work). We do not undertake to resolve this dispute. Even if it had been established, which it was not, that the University believed that Sharpless' work for Tech-

Beginning in the summer of 1947, Technitrol negotiated an agreement with, and developed a computerized airlines reservations system (called "Reservisor") for, American Airlines. Sharpless did some work on the Reservisor system during August 1947, and devoted his efforts to it after joining Technitrol full-time in October 1947. Eickert, who had left the Moore School to join Technitrol in April 1947, aided Sharpless occasionally on the project during that summer, and worked with him full-time from December 1947. On May 26, 1948 a patent application, which matured into the patent in suit, was filed, naming Sharpless and Eickert as joint inventors.

The basis of the license defense

Defendant's license defense is bottomed on the "Patent Rights" article of the EDVAC contract in which the University agreed to grant to the Government:

> * * * an irrevocable, nonexclusive, nontransferable and royalty-free license to practice, and cause to be practiced for the Government, throughout the world, * * * each Subject Invention in the manufacture, use and disposition according to law of any article or material, and the use of any method. * * *.

"Subject invention" was defined as

> * * * each invention, improvement and discovery (whether or not patentable) conceived or first actually reduced to practice (i) in the performance of this contract * * *, or (ii) in the performance of any research and development work relating to the subject matter hereof which was done upon the understanding that this contract or any subcontract hereunder would be awarded * * *.

Both Sharpless and Eickert knew or should have known of this patent license clause, as well as the comparable article in the ENIAC contract, and agreed, actually or in effect, to conform to their requirements. Plaintiff is, of course, likewise bound.

Since the defendant does not urge that the invention, improvement or discovery embodied in the Sharpless patent was actually reduced to practice in the course of performance of the EDVAC contract, our problem is to decide, first, what was the date of initial conception, and, second, whether that conception occurred "in the performance of" the EDVAC agreement or "in the performance of any research and development work relating to the subject matter hereof [*i. e.*, the EDVAC contract] which was done upon the understanding that [the EDVAC] contract * * * would be awarded."

[2] The parties and the trial commissioner have attacked these questions by first seeking to define the full scope of the patent claims, particularly with respect to the position volatility feature. We have decided, however, not to take that route and, instead, to advance toward the solution of the license problem without, at this time, determining the exact reach of the patent claims. We choose to avoid, for the present, this troublesome issue because our tentative appraisal suggests that, in this instance, the question of patent scope cannot well be resolved without inquiring simultaneously into patent validity—and the issue of validity has not yet been tried out in this litigation. The controversy over patent scope turns mainly on whether the claims (except for claim 16) disclose the automatic or memory reset feature counteracting position volatility. This aspect is not expressly recited in any of the claims, but the trial commissioner found, and plaintiff agrees, that under 35 U.S.C. § 112 the "means" clauses of the claims incorporate this feature.[9] Defendant disagrees very strongly and contends, also, that the specifications and drawings do not support the claims as construed in this way. The parties battle strenuously over these issues, and the artillery from both sides is heavy. As we see it now, this conflict should not be resolved apart from, or prior to, a consideration of the validity of the claims if so read. Since it is the patent claims which determine the legally protected subject matter of a patent (Continental Paper Bag Co. v. Eastern Paper Bag Co., 210 U.S. 405, 419, 28 S.Ct. 748, 52 L.Ed. 1122 (1908); White v. Dunbar, 119 U.S. 47, 51–52, 7 S.Ct. 72, 30 L.Ed. 303 (1886)), in construing the claims (with respect to the automatic reset feature) in order to define the invention for license purposes we would be in large part predetermining the patent's validity. Any construction of the claims which we adopted now would govern in subsequent proceedings on validity and infringement (see Dominion Magnesium Ltd. v. United States, 320 F.2d 388, 162 Ct.Cl. 240 (1963)), and that reading would be measured against the requirements for patentability: novelty, utility, and non-obviousness. See 35 U.S.C. §§ 101–103 (1964). In determining validity, as the *Dominion* case and many others illustrate, courts must frequently choose between a narrow construction of the claims that upholds the patent and a broad construction that strikes it down. We do not wish to make that choice at this stage, believing that it would be both unwise for the court and unfair to the parties to affix a meaning to the claims in the absence of further proceedings, including the making of a record, on validity.

Moreover, it is unnecessary to delimit fully the scope of the patent claims in order to move toward resolution of the license issue. The contractual provision does not tie the Government's license to the patent laws; any invention, improvement or discovery conceived in the course of performance of the EDVAC contract, whether or not patentable, is licensed to the Government.[10] We may therefore begin to determine the scope of the license by comparing the substantive elements of the Sharpless system with the work done under the ENIAC and EDVAC contracts. As our discussion will show, we can block out much of the answer to the license problem even though we do not, and cannot, decide it entirely at this time.

Conception during the period of the ENIAC contract

[3] In deciding whether the Government has a license, one basic question is when was the Sharpless invention (or inventions) conceived. Conception is a pivotal if somewhat nebulous notion in patent law, which is defined (1 Walker, Patents § 45 (Deller's 2d ed.) at 191–92) as "* * * the formation in the mind of the inventor of a definite idea of a complete and operative invention as it is thereafter to be reduced to practice * *. The date of conception is the date when the inventive idea is crystallized in all of its essential attributes and becomes so clearly defined in the mind of the inventor as to be capable of being converted to reality and reduced to practice by the inventor or by one skilled in the art." In this instance there is no real difficulty with the timing of "conception". The record makes it plain, in

nitrol involved no impermissible overlap with the EDVAC project, this would not determine the Government's rights as licensee (Mine Safety Appliances Co. v. United States, 364 F.2d 385, 391, 176 Ct.Cl. 777, 787 (1966)).

9. 35 U.S.C. § 112 says that an "element in a claim for a combination may be expressed as a means * * * for performing a specified function without the recital of structure * * * in support thereof, and such claim shall be construed to cover the corresponding structure * * * described in the specifications and equivalents thereof." See Ellicott Machine Corp. v. United States, 405 F.2d 1385, 1390, 186 Ct.Cl. 655, 664–665 (1969); Stearns v. Tinker & Rasor, 252 F.2d 589, 597 (C.A.9, 1957). The trial commissioner found that the register-selection function of the claimed system is performed, in part, by the two-channel clock disk which he thought to be "corresponding structure described in the specification" within the meaning of § 112.

10. The corresponding license provision of the ENIAC contract is framed in somewhat different language, but, in our view, gives the Government identical rights to inventions or discoveries made in the course of that contract. See note 6, *supra*.

our view, when the various components of the Sharpless invention or inventions (however broadly or narrowly defined) first became crystallized.

It is clear to us that the elements of the Sharpless system, except for the automatic reset feature (dealing with position volatility), were all conceived prior to Sharpless' cessation of employment with the Moore School (October 15, 1947) and during the performance of the EDVAC contract. First, the defendant introduced a set of documentary exhibits made up of sketches and written material prepared by Sharpless in the first half of August 1947. Defendant's expert witness testified, without substantial contradiction by plaintiff, that the drawings collectively disclosed an information storage system with sufficient clarity to have enabled its reduction to practice by a person skilled in the art existing in August 1947, without the need for exercise of any new or unobvious faculties, techniques and means. The witness also said that every element and combination contained in the Sharpless patent was revealed in the drawings.[11] This evidence shows that, except for the automatic reset facet, the Sharpless system was crystallized by the end of August 1947.

These drawings are themselves sufficient to establish conception by Sharpless before August 15, 1947, but there is more. The disclosures in these drawings are confirmed by a set of drawings made by Sharpless in the first two days of October 1947 while still on the Moore School payroll (see footnote 7, *supra*). These later drawings reveal further specific details of the keyboard and scanning devices shown in the earlier drawings, and are fully consistent with them and with the defendant's expert's testimony as to what the August drawings taught one skilled in the art.

[4, 5] In addition to this convincing documentary material, there are significant admissions by plaintiff which date conception of the invention before Sharpless left the university. These prior statements cannot be discounted on the ground that their substance has not been otherwise proved; all that is necessary to constitute an admission is a previous statement by an adversary party which is inconsistent with the position he is taking in litigation. Employers Mutual Casualty Co. of Des Moines v. Mosqueda, 317 F.2d 609, 612 (C.A. 5, 1963); Cox v. Esso Shipping Co., 247 F.2d 629, 632 (C.A. 5, 1957). The trier of fact can rightly take account of such admissions, although they are not, of course, conclusive if there is opposing evidence. La Flare v. Chase, 8 App.D.C. 83 (1896).

The first set of admissions occurred in a patent office interference proceeding between the Sharpless patent application and one filed by another. An interference is a procedure initiated by the Commissioner of Patents which seeks to determine the priority of invention between two applicants who are claiming the same invention, or between an applicant and a patentee. 35 U.S.C. § 135 (1964). The Sharpless application was the later filed, so Sharpless was designated the "junior party" and was required to file a "Preliminary Statement," a sworn document substantiating its claim to priority. See Patent Office Rules of Practice 201, 215, 216, 37 C.F.R. §§ 1.201, 1.215, 1.216 (1970). Sharpless and Eickert swore in this statement: (1) that the first drawing of the invention defined by the count in interference was made during August 1947; (2) the invention was first disclosed to others during July 1947; and (3) the active exercise of reasonable diligence towards reducing the invention to practice began during July 1947.

The interference was later amended by adding several new counts, including one which eventually issued as Claim 16 of the Sharpless patent. Sharpless' attorneys filed a so-called Rule 233(e) statement (*as amended*, 37 C.F.R. § 1.231(f) (1970)) which said that the dates originally sworn to in the preliminary statement would govern the new claims. The Rule 233(e) statement therefore reaffirmed the dates earlier sworn to and is equivalent to a new sworn statement.

These interference proceeding admissions, made fourteen years before the filing of the petition in the present action, are strong evidence of the time of conception. Their weight is buttressed by the failure of both Sharpless and Eickert to repudiate them in their testimony in this case. And they are not the only admissions in the record. In the course of an infringement proceeding in a federal district court between Technitrol Engineering Co., Inc. and the Sperry-Rand Corporation,[12] those parties agreed to exchange formal statements as to the dates of conception on which they would rely. Eickert, in his capacity as President of Technitrol, said:

> As presently advised, the earliest dates of conception of the inventions which are the subject of the Sharpless, et al. patent No. 2,611,813 upon which the plaintiff will rely at the trial of this action is *during the period from June 25, 1947 to July 6, 1947*. (Emphasis added.)

Sharpless was, of course, still working on the EDVAC contract for the Moore School during that period.

Taken together, these drawings and admissions are ample to establish that every element of Sharpless' "Magnetic Data Storage System", except the automatic reset feature, was conceived before Sharpless left his employment at the Moore School. There are also other, lesser, indications in the record supporting this conclusion, and there is very little to the contrary. Plaintiff's argument for a later conception date rests mainly on its claim that the automatic reset feature is central and necessary to the invention (a position which, as we have noted, the defendant strongly disputes). And it is quite true that the record just as clearly discloses that the automatic reset feature (the solution to position volatility) was not conceived until 1948 after both Sharpless and Eickert had left Moore and the University of Pennsylvania. This is established by a drawing by Sharpless showing the Reservisor system (developed by Technitrol for the air carrier) as envisioned on January 1, 1948. The central storage system consisted of, among other things, information disks and a clock disk mounted on a common shaft. However, the clock disk did not have the one pulse per revolution channel by which the memory could be reset to avoid position volatility. Recognizing the problem, Eickert, sometime after January 1, 1948, suggested modifying the clock disk with the single pulse channel.

"In the performance of this contract" for federal license purposes

We now come to consider whether the components of the Sharpless conception —again, excluding the automatic reset feature—may still fail to have been conceived "in the performance of" the EDVAC contract, although temporally developed before Sharpless separated from the Moore School. It is possible, of course, for an invention to lie outside the performance of the government contract, even though crystallized during the period of that project, because its subject matter is distinct from the government work. We have stated, in large part, the principles which govern construction of government license clauses, depending on conception "in the performance of [the] contract," in Mine Safety Appliances Company v. United States, *supra*, 364 F.2d 385, 176 Ct.Cl. 777 (1966). The inventors in that case were employed by a university in a government-sponsored aviation medicine program designed to study the effects of acceleration on the human body. The subject matter of the patent was an energy-absorbing crash helmet, which, it was claimed, was beyond the scope of the

11. The automatic reset feature which plaintiff contends is covered in the patent, and defendant says is not so embodied, was not shown in these drawings. As indicated *supra*, we do not now decide whether that feature is covered by the patent.

12. Civil Action No. 7305 (N.D.N.Y.1959).

government contract. In rejecting that position, the court said that the license provision was operative whenever the "private" invention bore a "close connection" or a "close and umbilical connection" to the government-underwritten research. 364 F.2d at 389, 391, 176 Ct. Cl. at 783, 787. Furthermore, the court declined to restrict the license clause to circumstances where every component of the invention had been discovered in the course of contract performance. The Government would be licensed (364 F.2d at 391, 176 Ct.Cl. at 787–788), "[a]t least in those instances in which the invention was conceived or practiced during the existence of the contract, * * [where] an important factor in the invention was itself within the contractual scope, or resulted directly from the course of contract performance."

What Mine Safety teaches is that the issue of license *vel non* should be approached liberally by asking what the United States (acting for its taxpayers) can fairly be said to have purchased through its sponsorship of the contract project. The Federal Government has the right to use, royalty-free, those ideas, improvements, discoveries, and inventions—crystallized during performance of the federal contract—which have a "close and umbilical relationship" to the work and research funded by the United States. Having borne the expense of that effort, the public is entitled to enjoy the fruits without further charge. Accordingly, as we said in *Mine Safety*, "[i]t is fitting to read the license-grant of Section 17 [which is the same as the license clause of the EDVAC contract] liberally, * * * and not to confine it severely within a narrow compass." 364 F.2d at 392, 176 Ct.Cl. at 789.

The scope of the EDVAC contract

The original ENIAC contract was for pioneer research in the digital computer field. The ENIAC machine which was ultimately developed incorporated a great number of vacuum tubes, including a small capacity internal vacuum tube memory, and could be programmed in a variety of ways through manual switches and plugboards to perform a number of different functions. The ENIAC's capabilities were limited, however, by its clumsy programming techniques, and even before the ENIAC machine was completed the Research Division of the Moore School began considering design modifications, including the use of magnetic disks and drums for the internal storage of information. These improvements formed the basis of the EDVAC, a second generation general purpose computer. The amendment of the ENIAC contract, previously mentioned, which broadened the scope of work to include experimentation on the EDVAC, also required that a complete work report be delivered to the Government. This report, entitled "Automatic High Speed Computing, a Progress Report on the EDVAC", was prepared by Eckert and Mauchly, employees of the Moore School and joint inventors of the ENIAC. Dated September 30, 1945, the report disclosed proposed characteristics of the EDVAC, among the most important of which was a high speed, large capacity memory. The report specifically referred to magnetic storage devices, first proposed in 1944, as an area for exploration, although it indicated that an acoustic mercury delay line system looked more promising at the time.

The original, separate EDVAC contract called for "research and development" on a "preliminary model of a small Electronic Discrete Variable Calculator". The small model was to serve to "demonstrate the feasibility" of a full-scale EDVAC having the properties described in the Eckert and Mauchly report. The feasibility model did not exhaust the goals of the contract. Indeed, amendments to the EDVAC grew from a small preliminary model to a versatile full-size machine capable of solving a variety of sophisticated problems, and its growth in complexity was paralleled by the increase in its cost to the Government, from an original contract price of $100,000 to one of $409,700. The EDVAC became the subject of a patent,[13] which disclosed and claimed several different central or internal memory elements including, it should be noted, both acoustic mercury and magnetic disk devices.

The record therefore fully supports the conclusion that a magnetic information storage device—the system used in the Sharpless patent—was well within the scope of the EDVAC contract. Plaintiff contends otherwise, and the trial commissioner agreed, on the ground that the EDVAC machine actually built employed an acoustic mercury delay line device. But the ENIAC and EDVAC contracts were for research and development and their scope cannot fairly be limited to the features embodied in the machines physically produced. The Government spent nearly $900,000 on the ENIAC and EDVAC contracts; it was paying not merely or even primarily for specific machines but for the advancement of knowledge in computer technology produced by the research. Indeed, the ENIAC machine was obsolete before it was even completed—the knowledge gained in producing it gave engineers at the Moore School the ability, which they recognized, to create a much more useful computer, the EDVAC. There was a continuous line of research running from the ENIAC project through the EDVAC contract, devoted to increasing human understanding, as well as the actual performance, of high speed computers. The particular machines built under the two interrelated programs were not the sole aim of the contracts, nor the only results for which the Government paid. It paid, too, for the exploration of the field and the acquisition of new knowledge,[14] and it is entitled to the crystallized ideas, improvements, and inventions emerging from that process of ongoing study, inquiry, and creation. Scientific research is not a straight and narrow journey, with blinders, along a single path to a known destination. In the process of discovery and invention under a research and development program many roads are uncovered; some are pursued immediately and some must wait for another day. One "product" of the research is the overall accretion in knowledge, and this encompasses the untraveled ways sketched out, as well as the trodden ones. The possible use of a magnetic memory system was revealed by the ENIAC-EDVAC research and was well within the scope of the EDVAC contract.[15]

True, the EDVAC program ultimately produced a model machine based on the acoustic mercury system, rather than the magnetic data storage system preferred by Sharpless. But this specific end-result did not limit or characterize the broad scope the EDVAC project had had from its inception, nor did it mean that the United States abandoned or gave up its claim on the research that had been done on other systems or avenues, or its right to pursue those paths under the EDVAC contract. We have no doubt

13. United States Patent No. 2,629,827 issued to Eckert and Mauchly in 1953.

14. Dr. Travis, supervisor of research at the Moore School, testified (at the trial on the license issue) concerning the EDVAC contract:

"If you read the language carefully, you are struck with the conclusion that the thing the Government wants is a computer having the comprehensive properties envisioned in a report, and that the small model as a means to an end, and that certainly a total means to an end would include not only the hardware that might be incorporated in such a model, but certainly recommendations for further improvements and ideas that were generated, during the course of the building of the small model in order to achieve the end result which the Government is really interested in."

15. Since we find that all of the Sharpless system, except for the automatic reset feature, was conceived in the performance of the EDVAC contract itself, we need not consider whether, and to what extent, it would also be covered by the ENIAC contract, either as an independent agreement containing a license provision or, under the EDVAC license clause, as "research and development work relating to the subject matter hereof [the EDVAC contract] which was done upon the understanding that this contract or any subcontract hereunder would be awarded."

that if it had been decided by the EDVAC project managers, in July-August 1947, that it would be useful to do further work on a magnetic data storage system (as well as an acoustic mercury system) that such further research would have been within the general scope of the EDVAC agreement as it stood at the time. So also, the Sharpless patent cannot be isolated from the EDVAC on the ground that the former is specifically designed as an inventory control system while the latter is not so limited. The EDVAC was a general purpose computer capable of being programmed to perform many tasks, including inventory control, and that function is hardly remote or unlikely for the Federal Government, which has a unique problem in keeping track of its far-flung property.

The sum of it is that we find the *Mine Safety* requirement of a "close and umbilical connection" between the government-sponsored research and the "private" invention to have been fully satisfied in this instance: the ENIAC spawned the EDVAC which in turn revealed the concept of a magnetic data storage system in an unbroken chain of descent. All of the Sharpless invention (leaving aside the automatic reset feature) was therefore conceived during and in the performance of the EDVAC contract. We are not saying this is so merely because Sharpless happened to use some knowledge or idea gained through his work on that project.[16] We are saying, rather, that the discrete "invention, improvement and discovery" which Sharpless conceived before he left the project—his conception of a magnetic storage data system, embodied in the patent in suit—had a very close and integral connection, as a whole, with the government-financed project. His "invention, improvement and discovery" was not separate from, or independent of, the ongoing EDVAC program; on the contrary, it was inseparable from it. Accordingly, we hold that the United States is licensed as to all elements of the Sharpless invention (excluding, for the time being, the automatic reset feature).

The automatic reset feature

As shown above, and practically conceded by defendant, the automatic reset phase of the Sharpless patent was conceived after Sharpless left the Moore School. Defendant argues that, nevertheless, it is licensed (assuming *arguendo* that it forms part of the patented invention at all) because it is, at most, a minor part of the invention, the major portion of which was conceived while the inventor was doing government work. In *Mine Safety, supra*, we did not have to decide whether an invention could be licensed—although not conceived or practiced until after the end of the contract's life—because of its close connection with the prior federal program. That problem does arise here, at least potentially, with respect to the automatic reset feature. We now determine that that feature, if it is validly covered by the patent, is not licensed since it was conceived *after* performance and not "*in*" the performance of the EDVAC contract. We make this holding on the assumption (which will have to be tested in later proceedings) that the automatic reset feature is a non-obvious improvement or extension of the magnetic data storage system conceived by Sharpless before he separated from the University of Pennsylvania. We think that the terms of the license clause before us preclude the blanketing of a non-obvious "invention, improvement and discovery" conceived after the termination of the inventor's federal connection, even though that separate invention may have a close connection with the preceding government work. The clause, as worded here, does not purport to extend its reach chronologically, by mortmain, into the indefinite future. The unqualified phrase "*in* the performance" of the federal contract has both temporal and substantive connotations; in the former

16. Sharpless admitted on the stand that, without his participation in the ENIAC-EDVAC program, he probably would not have been able to make his invention

aspect, it excludes post-contract developments which are new and not obvious.

Conclusions and directions for further proceedings

As we have already said, we do not now decide the scope of the Sharpless patent (with respect to the automatic reset feature); that issue should be canvassed and resolved in further proceedings along with the question of patent validity. In the light of that deferral of final decision, our present decision on the license defense is, first, that claim 16, which was found by the trial commissioner and is agreed by the parties to be entirely independent of the automatic reset device, is fully licensed to the Government, and, second, that the other three representative claims (5, 19, 23) are licensed to the Government except to the extent they may be found hereafter to be validly limited to the automatic reset feature. In other words, the only possible area of infringement liability concerns the solution to position volatility, *i. e.* the automatic reset feature; all other aspects of the Sharpless system and patent are licensed to the Government.

Before any conclusion of infringement is reached, it must be determined in the subsequent proceedings that (1) the patent properly claims the solution to position volatility (the automatic reset feature); (2) the patent is valid as so construed; and (3) the defendant has appropriated the automatic reset feature to its own use. We also emphasize that, even if the plaintiff is successful in proving infringement of the reset feature, such a showing can impose no infringement liability on defendant for use of any or all of the other elements of the magnetic data storage system embodied in the patent, which we now hold are licensed to the United States. Any recovery will be limited to a reasonable royalty for the reset feature alone. Cf. Cover v. Chicago Eye Shield Co., 130 F. 2d 25 (C.A.7, 1942). If it turns out that a proper royalty limited to this particular aspect cannot be separately established, the trial commissioner should consider whether plaintiff is entitled to any recovery at all. *Cf.* New Jersey Zinc Co. v. Singmaster, 4 F.Supp. 967, 980–981 (S.D.N.Y.1933), modified, 71 F.2d 277 (C.A. 2, 1934); U. S. Colloid Mill Corp. v. Myers, 6 F.Supp. 283, 285–286, 268 (S.D.N.Y.1934).

The case is remanded to the trial commissioner for further proceedings consistent with this opinion.

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MAGNETIC DATA STORAGE SYSTEM

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FIG. 1.

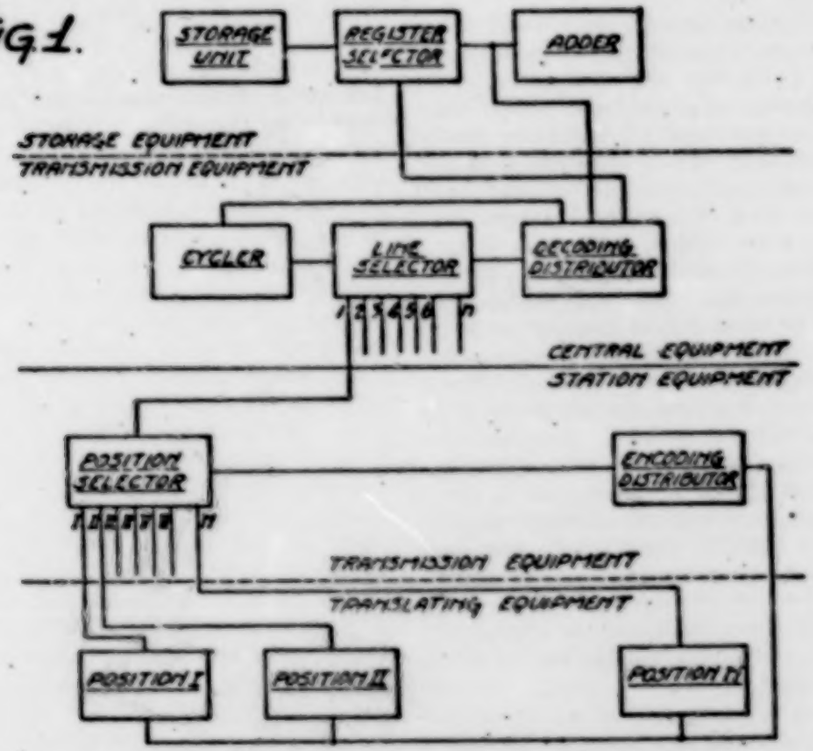


FIG. 2

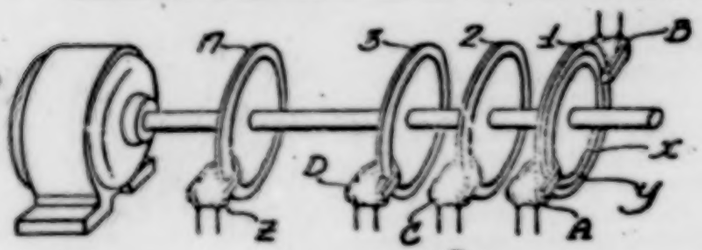
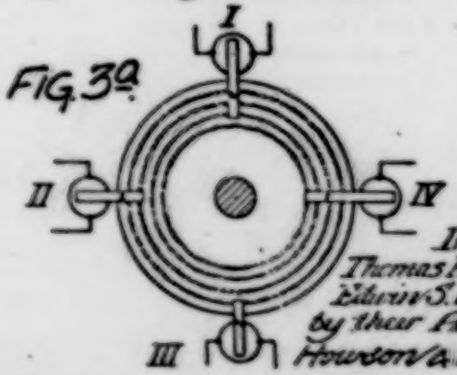


FIG. 3b.

FIG. 3a.



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MAGNETIC DATA STORAGE SYSTEM

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FIG. 4.

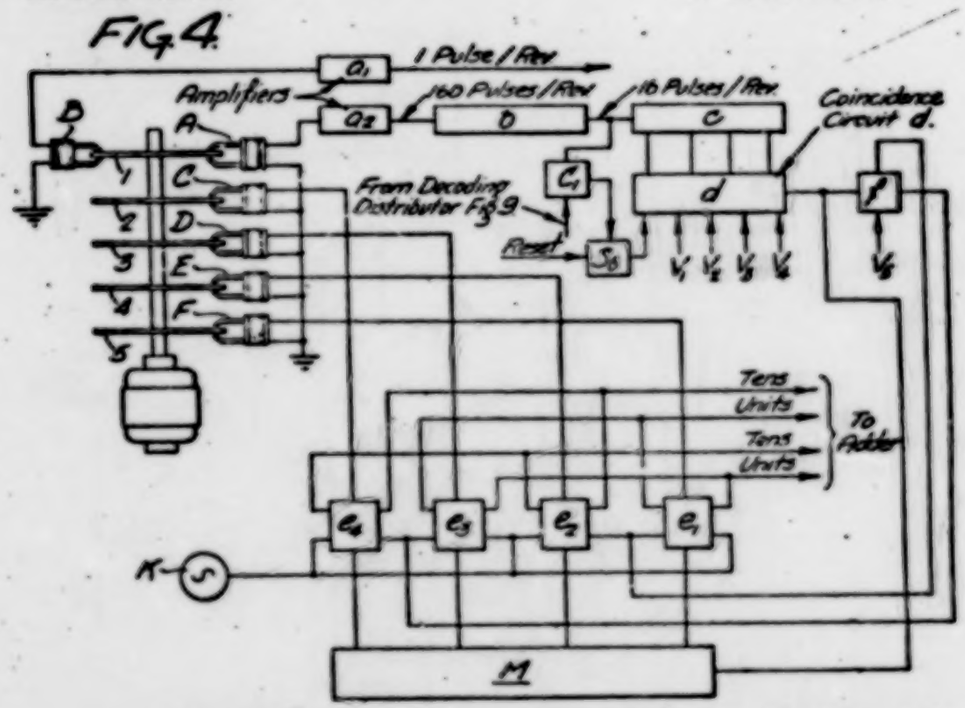
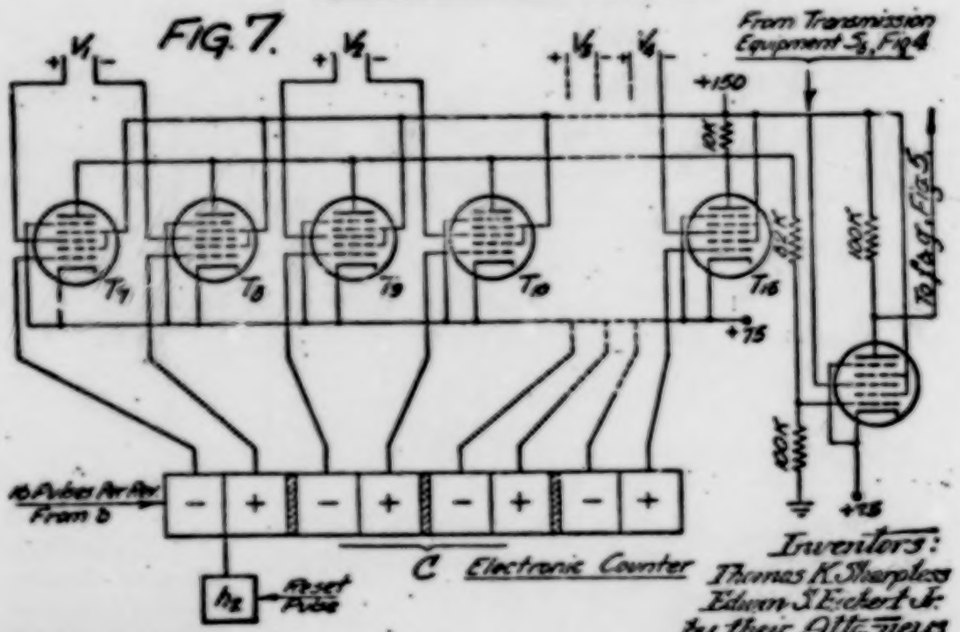


FIG. 7.



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MAGNETIC DATA STORAGE SYSTEM

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FIG. 5.

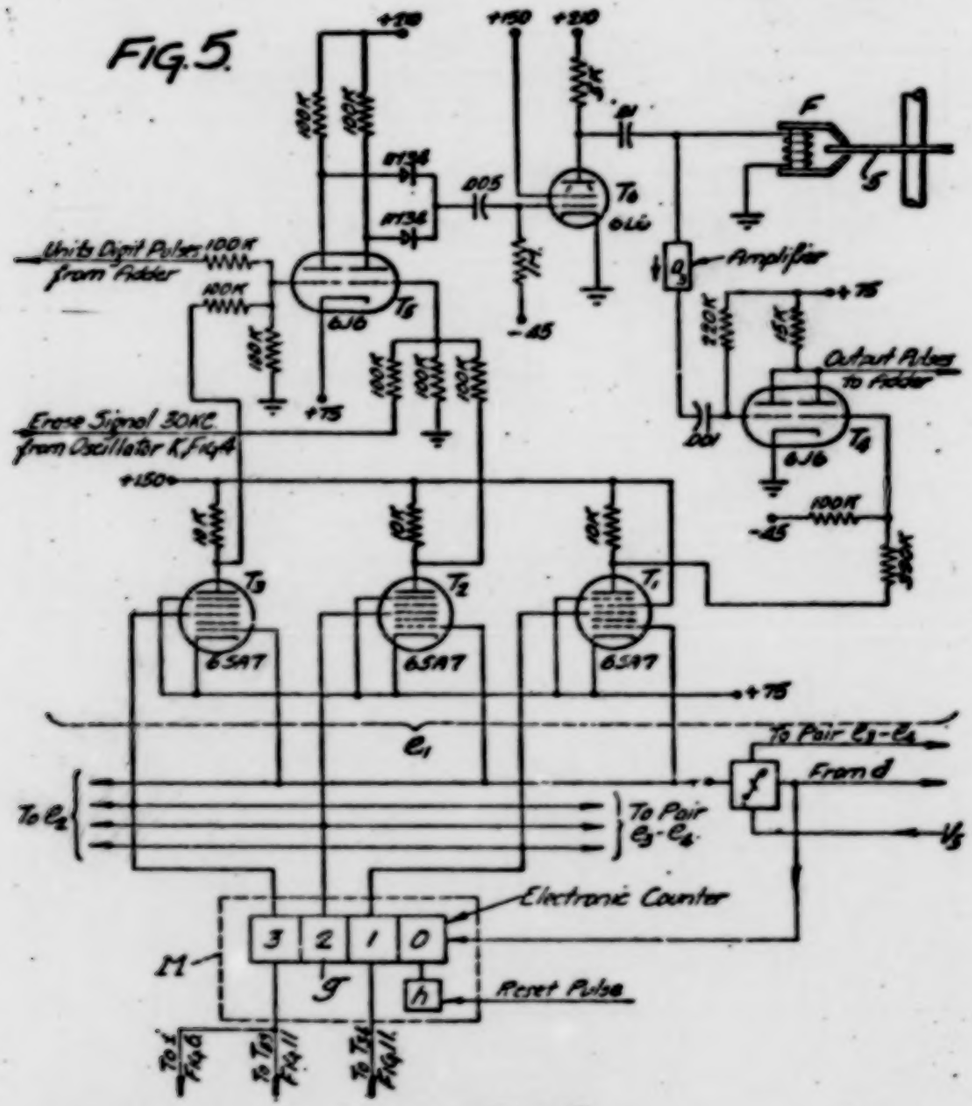
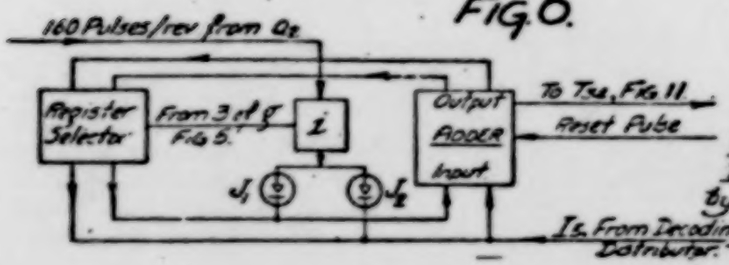


FIG. 6.



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MAGNETIC DATA STORAGE SYSTEM

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FIG. 8.

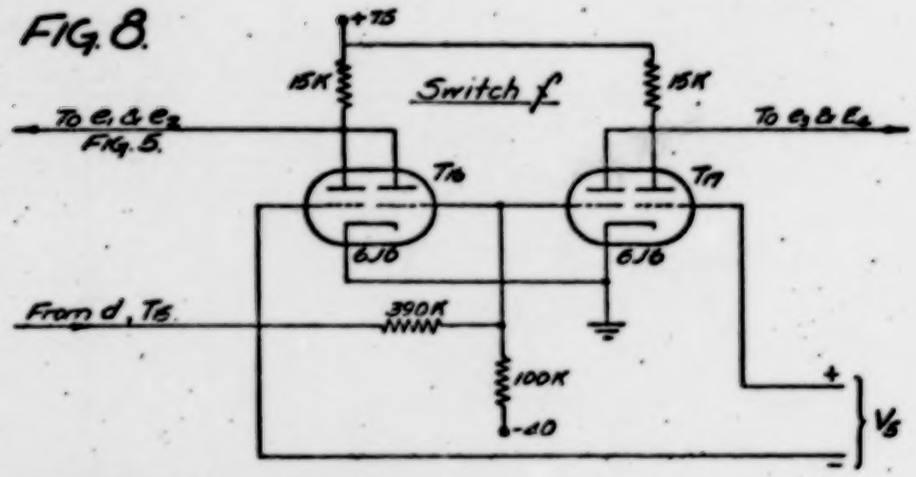

FIG. 10.

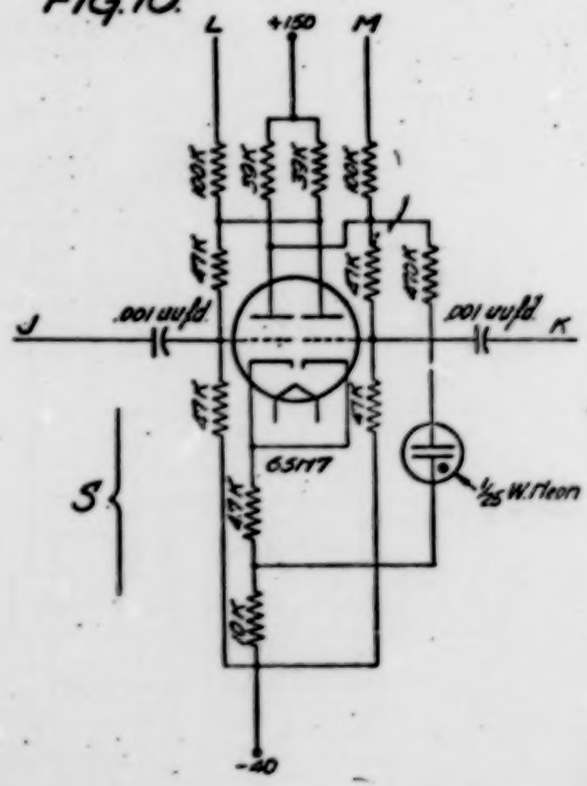

FIG. 15.

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FIG. 9.

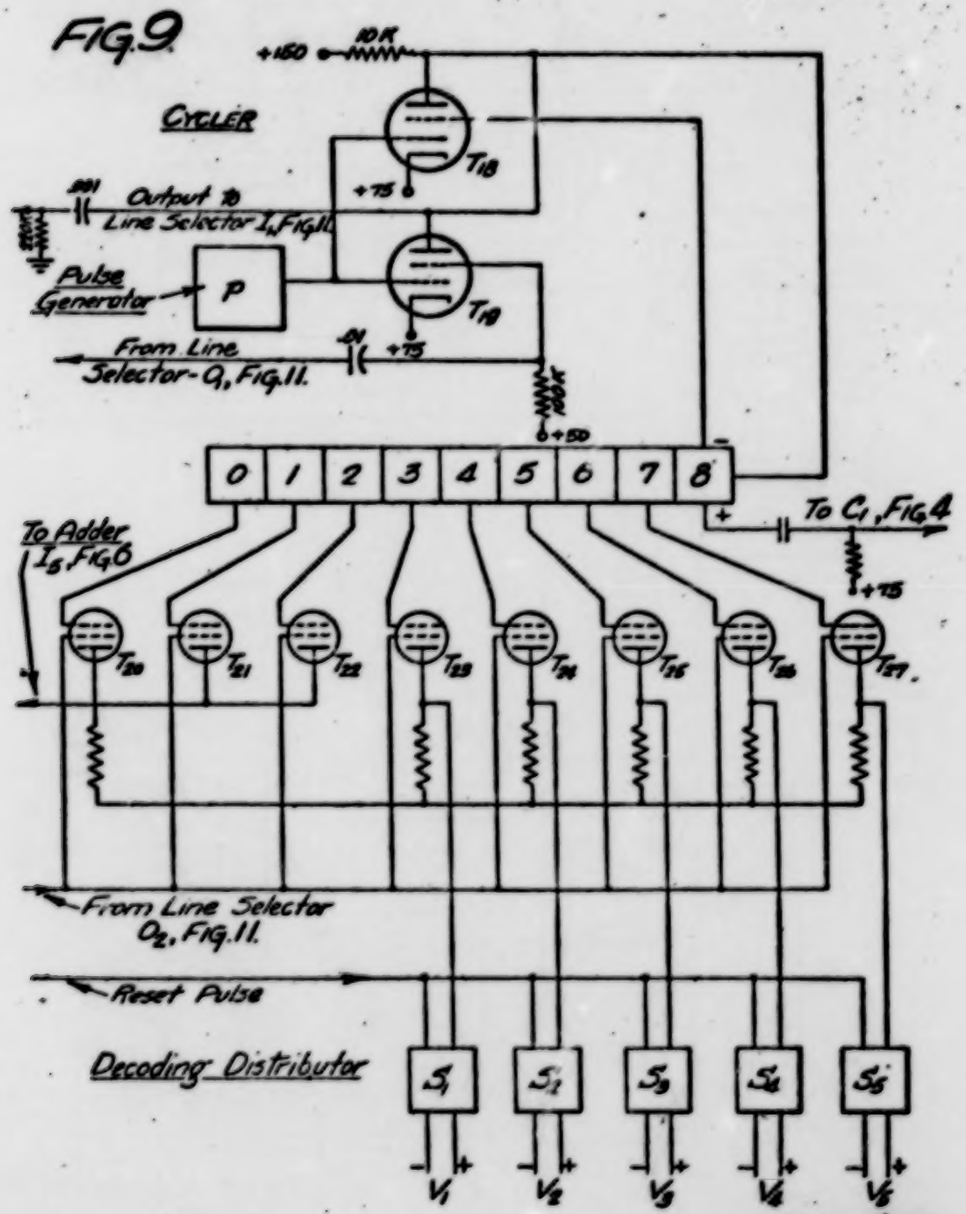

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FIG. 11.

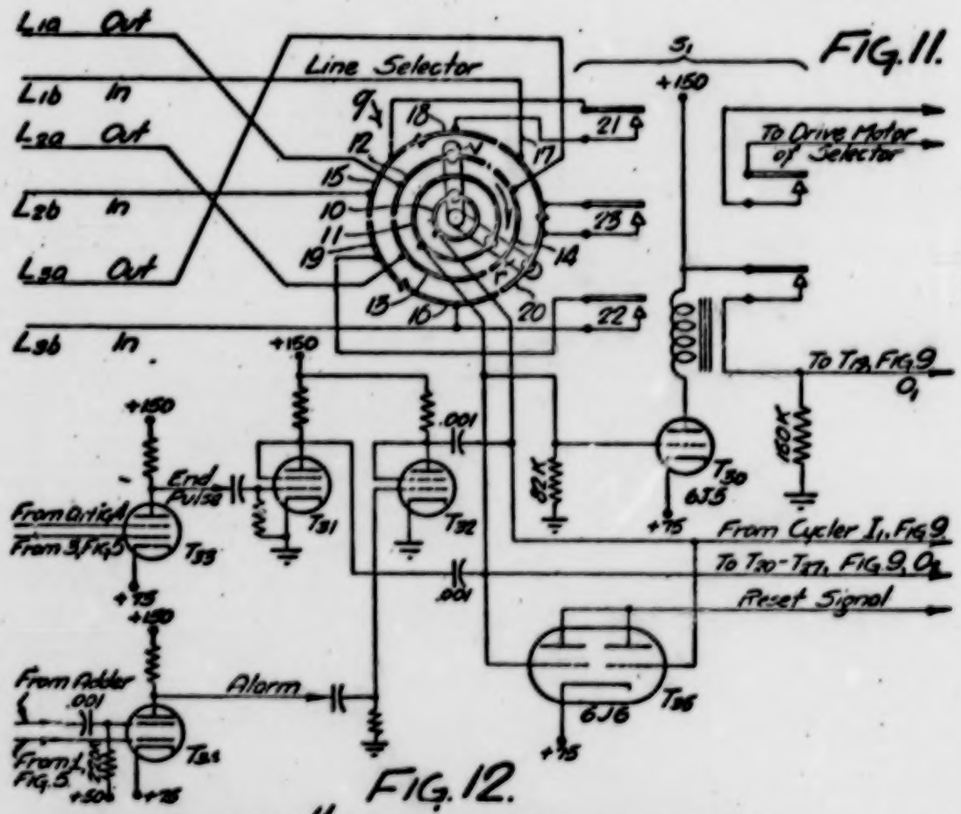
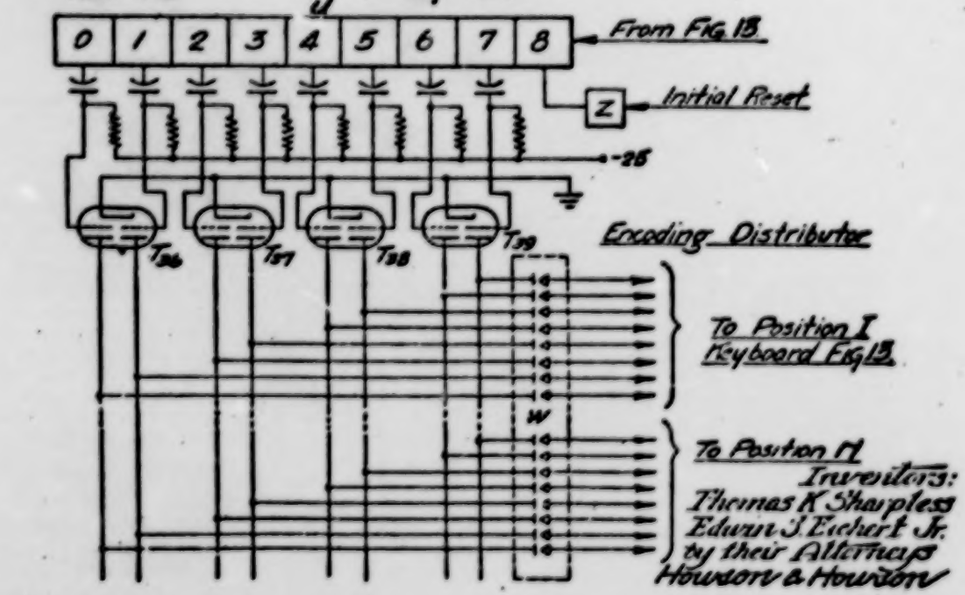


FIG. 12.



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Sept. 23, 1952 T. K. SHARPLESS ET AL 2,611,813

MAGNETIC DATA STORAGE SYSTEM

Filed May 26, 1948 7 Sheets-Sheet 7

FIG. 13

Position I.

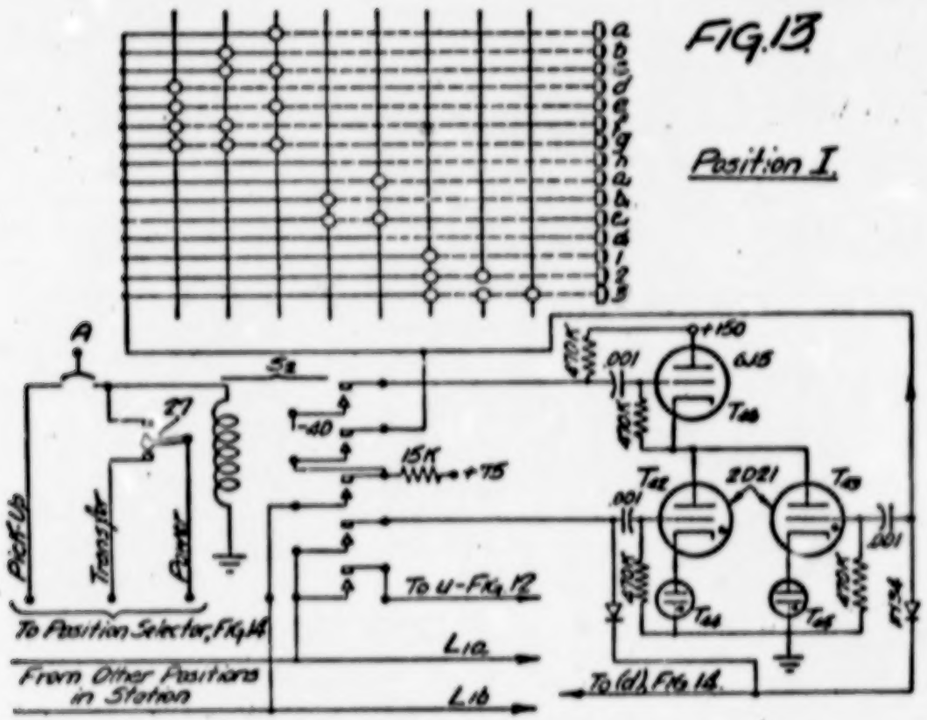
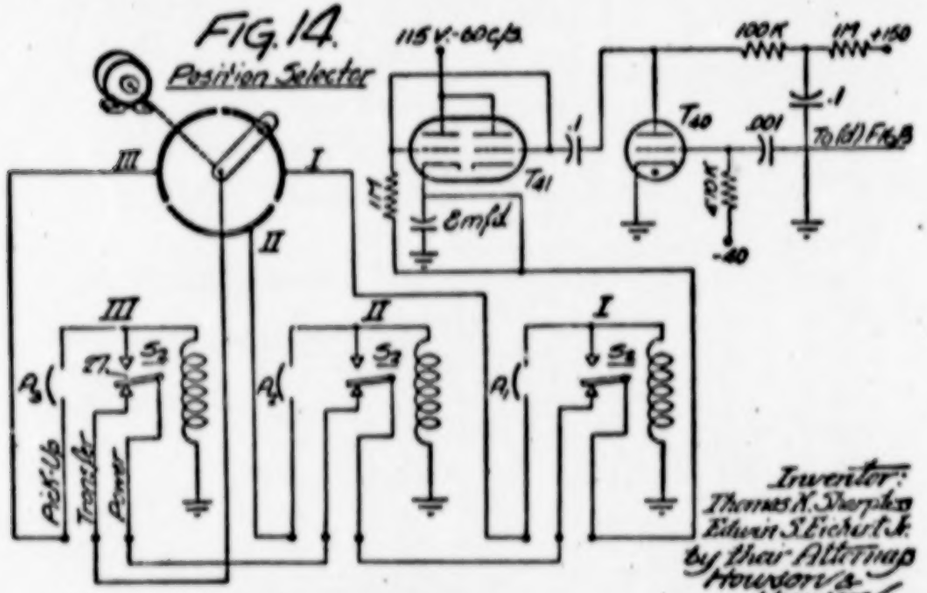


FIG. 14.

Position Selector



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MAGNETIC DATA STORAGE SYSTEM

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This invention relates to systems for storing information, especially where it is desired to transmit, receive and record the information. More particularly, the invention relates to systems where the information is conveyed by means of groups of electrical impulses of the digital, or pulse and no pulse, sort. While the invention may be used for various purposes, by way of example it may be used to store information concerning reservations on public carriers such as airplane lines, railway lines, etc.

The principal object of the invention is the provision of a system whereby persons at a plurality of remote positions may insert and withdraw information from a centrally located storage unit comprising a plurality of registers each of which will hold its information permanently unless changed by the insertion of new data from any one of the positions. In addition, the storage unit may have associated with it an adding unit in order that numerical information may be stored and accumulated.

A more specific object of the invention is the provision of such a system wherein the information is stored by magnetic recording of pulses on rotating magnetic disks having register areas which are selected through the agency of register-selection voltage combinations representative respectively of the registers and occurring successively in timed relation with the rotation of the disks, the selection of the registers being effected through coincidence of said register-selection voltage combinations and voltage patterns produced by action on the part of an operator.

Other objects and features of the invention will be apparent from the following description.

In the accompanying drawings:

Fig. 1 is a block diagram of an information storage system according to the invention;

Fig. 2 is a perspective view showing the preferred form of the central storage unit;

Figs. 3a and 3b are face and side views respectively of a register disk employing a plurality of recording heads, this being a possible alternative arrangement, as hereinafter described;

Fig. 4 is a generalized illustration of the register selector;

Fig. 5 is a diagrammatic illustration of one of the units of the register selector;

Fig. 6 is a generalized illustration showing the electrical arrangement of the adder in association with the register selector;

Fig. 7 is a diagrammatic illustration of the coincidence circuit d employed in the register selector;

Fig. 8 is a diagrammatic illustration of the electronic selecting switch f of Fig. 4;

Fig. 9 is a diagrammatic illustration of the cycler and the decoding distributor;

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Fig. 10 is a diagrammatic illustration of an electronic switch which is employed at various places in the system;

Fig. 11 is a diagrammatic illustration of the line selector;

Fig. 12 is a diagrammatic illustration of the encoding distributor;

Fig. 13 is a diagrammatic illustration of the equipment at one position of a station;

Fig. 14 is a diagrammatic illustration of the position selector; and

Fig. 15 illustrates a possible arrangement which may be used in the push-button keyboards.

General description of system

Figure 1 shows a generalized view of the subject system. It shows the central storage equipment, the transmission equipment, and the translating equipment. It should be pointed out that the transmission equipment consists of a plurality of lines feeding from a like number of stations. In addition each station permits the use of a plurality of positions. Each position of the translating equipment has thereat a keyboard for inserting and requesting information and an indicator to display information from the storage unit. By setting up the proper keys the operator may select any one of the registers in the storage unit. Likewise, by the setting of other keys he may request the information in that particular register or insert new information in that register. That only one position in a station be operative at any time is assured by an interlocking circuit working in conjunction with the position selector, which guarantees that each position get its turn on the line. The line selector of the central equipment works in a similar manner to prevent interference between lines.

The information for the selection of the register and the information to be stored are transmitted in the form of time division coded groups of electrical impulses, as is common in Teletype systems. In this description such a pulse group will be called a word. The uses of the encoding distributor, cycler, and the decoding distributor for producing the words, will be made clear in the detailed description of the transmission equipment. The register selector, working in conjunction with the decoding distributor, splits the word into its two components, using one part to select the proper register and sending the second or information part either into the register or adder as needed, or if it is merely a request, allowing the register contents to go into the transmission equipment.

The drawings show, diagrammatically and symbolically, the essential components of the system as generalized in Figure 1 and as it has been constructed and successfully operated. In the subsequent description, the component de-

vices and their functioning will be described in succession, commencing with the storage unit and proceeding through to one of the station positions, and then the complete operation of the system will be described.

Detailed description of the storage unit

The central storage equipment consists of a storage unit making use of the principles of magnetic recording for the purpose of storing the impulses. These impulses are recorded as discrete areas of magnetization around the periphery of a thin circular disk of suitable magnetic material, as shown in Figure 2. A plurality of such disks are mounted on a shaft driven continuously by a suitable motor. Referring to Figure 2, disk 1 is used as a master pulse source, or clock. It has permanently recorded on it two channels, *x* and *y*. Channel *x* carries a given number (e. g. 160) of pulses recorded at suitable intervals, leaving a small sector blank. Channel *y* carries one pulse located in about the center of the segment delineated by the blank sector of channel *x*. The recording heads A and B are located so that their air gaps cover respectively channels *x* and *y*. Each recording head is connected to a suitable vacuum tube amplifier to bring the pulses to a suitable voltage level for operating the rest of the system.

Still referring to Figure 2, disks 2 through n are used as register disks, each with a single head serving the purpose of recording pulses on the disk, reading the pulses on the disk, and erasing pulses from the disk. The number of disks actually employed will depend upon the requirements in any given instance. Each register disk contains a plurality of registers chosen by counting the impulses from the clock disk. For example, in the presently disclosed system, each register disk contains 16 registers of 10 pulse spaces each. These are delineated by noting every 10th pulse from the 160 pulses recorded on the clock disk.

It should be noted that several channels may be handled on one disk by placing the heads around the disk with their air gaps at different radial distances from the edge. Figures 3a and 3b show such an arrangement using four heads I to IV and four channels. The limitations on the number of channels thus available are set by the depths of the throat of the recording head, and by the closeness with which the magnetic spots may be placed on the disk.

Description of register selector

In the illustrated embodiment of the system, the register disks are used in pairs, one disk of a pair being used to record units digits of numbers, and the other disk of the same pair being used to record tens digits of the numbers. Figure 4 is a generalized illustration of the register selector, there being shown four register disks 2 to 5, of which disks 2 and 3 constitute one pair, and disks 4 and 5 constitute another pair. These pairs of disks are selected in a manner presently to be described.

The clock disk 1 gives 160 pulses per revolution through amplifier a_2 which pulses drive *b*, a scale-of-ten electronic counter. The 16 pulse per revolution output of this counter is used to operate a counter *c* consisting of four cascaded scale-of-two electronic counters. The outputs of the four counters give 16 unique combinations of positive and negative voltages per revolution, one for each of the impulses which enter it from *b*. These combinations are repeated each revolution. These output voltages are fed into the coincidence circuit *d* where coincidence of the voltage combination from *c* with that of the four input voltages $V_1 \ldots V_4$ produces an output voltage of a duration of 10 pulses, which is applied to two of the electronic switch and amplifier units $e_1 \ldots e_4$, thereby activating the associated recording heads which are used to "Write" input pulses in the register, "Read" pulses from the register, or to "Erase" the pulses already recorded in that register. The scheduling of these operations is carried out by unit M, and is explained below.

It can thus be seen that any one of 16 ten-pulse sectors around a register disk may be chosen by the 16 possible on and off combinations of $V_1 \ldots V_4$. In the system disclosed herein, numerical information is stored using a simple linear code wherein the digit to be stored is represented by a number of pulses equal to that digit, i. e., no pulses for 0, one pulse for 1, and so on to nine pulses for 9. Moreover this same system is designed to store numbers up to 99 and uses one register disk for the units digits and another disk for the tens digits. Thus e_1 is connected in parallel with e_3 so as to handle both digits of the number simultaneously on the disks 4 and 5. The block *f* represents a two way electronic switch, as hereinafter described, which serves as a means for selecting register disks 2 and 3 or 4 and 5, depending on V_5 being on or off.

The one pulse per revolution output supplied from the clock disk 1 through amplifier a_1 is used to initially set the counters so that the registers on the disks will always maintain the same relation with the pulses on the clock disk as checked by counters *b* and *c*, even though the power be shut off and later turned on with the counters coming up containing arbitrary counts.

The circuits of the amplifiers a_1 and a_2 are conventional vacuum tube amplifier circuits. The circuit details of the counters *b* and *c* are quite well known and have been described by Sharpless (Electronics, March 1948), Blume (Electronics, February 1948), and many others. The symbol K represents a conventional high frequency (e. g. 30 kc.) oscillator which produces the erasing signal. The blocks C_1 and S_4 represent devices whose nature and purpose will appear later.

Figure 5 shows the details of the switch and amplifier unit e_1 which is typical of all four units. In addition, Figure 5 shows how the unit M schedules the operations of Read, Write, and Erase. The block *f* is the same one shown in Figure 4. The block *g* represents 4 stages—0, 1, 2, 3—of linear electronic counter. The outputs of three stages are used to turn on the grids of the tubes T_1, T_2, T_3 respectively. The 0 stage has no output used, but is connected to the clear circuit, *h*, which sets the counter to 0 at the occurrence of a reset pulse. The counter *g* is fed from the output of *d* of Figure 4, thus stepping each time a coincidence is made in *d*. With no reset pulse present, counter *g* will step from 0 to 1, from 1 to 2, from 2 to 3, from 3 back to 0, and continue this cycle as long as impulses from *d* are present.

Still referring to Figure 5, coincidence of a signal from *f* on the first grids of tubes T_1 to T_3 with that of the output of the corresponding stage of counter *g* will produce a negative voltage swing at the plate of the tube in question. The Read circuit, which involves tube T_4 and

amplifier a_3, is activated by the signal from tube T_3. Tube T_4 is a double triode which is operated with a slightly positive bias on each grid and the plate load resistor chosen so that if either triode section is conducting, the level of voltage at the common plate connection is sufficiently low so as to render any subsequent circuits inoperative. Only if both triode sections are cut off will the plate voltage rise to 75 volts and operate the following circuit. It can thus be seen that only for the duration of the negative excursion of the plate of T_3 will the negative pulses applied to the other grid of T_4 come out at a voltage level sufficient to operate the output circuits. The negative pulses arrive at T_4 from amplifier a_3, which receives the pulses from recording head *F* and disk 5.

The Erase circuit which operates from tube T_3 accomplishes a similar object, i. e., that of allowing the high frequency erasing signal from oscillator K (Fig. 4) into the driving amplifier T_5 and thence into the head *F* thereby erasing pulses on disk 5 only for the duration of the signal from tube T_3. Here, as long as either input to the right-hand grid of T_5 is positive, the grid is maintained positive and the consequent diode action effectively prevents any appreciable signal appearing at the plate of the right hand triode section of double triode tube T_5. When the plate of tube T_3 swings negatively, the diode action of the grid of tube T_5 ceases and large signals appear at the plate.

The other half of tube T_5 works similarly to allow input pulses to be recorded on the disk only for the duration of the signal from tube T_3. The 1N34 crystal diodes are used in the plate circuit to prevent loading down of one plate by the plate of the other conducting half of tube T_5.

It can thus be seen that the functions of reading the disk, writing on it, or erasing from it may be accomplished. The reset pulse is used to initially set *g* to 0 when the power is turned on and also, as will be explained below, to make it possible to skip the Write or Erase operations under certain conditions.

As mentioned above, Figure 5 shows only the apparatus associated with register disk F. Similar apparatus will be provided for each of the other register disks, as represented by the blocks e_2 to e_4 in Figure 4.

The coincidence circuit of the block *d* of Figure 4 is detailed in Figure 7. The cascaded scale-of-two counters *c* are shown with each half indicating the polarity of its output voltage with respect to +75, the cathode level of vacuum tubes T_7 through T_{14}. The voltages $V_1 \ldots V_4$ appear each on two wires. One of the wires is positive and the other negative with respect to +75. These voltages and those from the stages of counter *c* are fed to the grids of tubes $T_7 \ldots T_{14}$, which are coincidence tubes similar in function to $T_1 \ldots T_3$ of Figure 5. Only five of the tubes $T_7 \ldots T_{14}$ are actually shown but the presence of the others will be understood from the illustration. With the pattern of voltages shown in Figure 7, it can be seen that every tube of the group $T_7 \ldots T_{14}$ has at least one of its control grids negative with respect to its cathode, thus permitting no flow of current through the common plate load resistor and allowing the plate line to rise to +150. This rise in voltage is delivered through the 82K and 100K step down circuit to one grid of tube T_{15}, and is sufficient to turn that tube on when the other grid is driven positive by the "go ahead" signal from the transmission equipment. On examination it will be seen that only when the voltage output pattern of $V_1 \ldots V_4$ and the counter *c* agree in opposite phase, as shown, will no current be drawn through tubes $T_7 \ldots T_{14}$ and a signal operate T_{15}. For example, if the $V_1 \ldots V_4$ pattern is + −, − +, − +, + −, the counter *c* must give a pattern − +, + −, + −, − +, to cut off all of the tubes $T_7 \ldots T_{14}$. It will be remembered from the description of the register selector that counter *c* only remains in any one state for ten pulse times and repeats its cycle with each revolution of the clock disk 1; thus the signal from tube T_{15} will have a duration of ten pulse times and will appear once each revolution at a different part of the revolution for each $V_1 \ldots V_4$ pattern.

Figure 8 shows the electronic switch represented by block *f* of Figure 4, and shows how the ten pulse signal from T_{15} is switched into one or the other of the two channels leading to e_1 and e_3 or to e_2 and e_4. Here again, a double triode coincidence circuit similar to that of the T_4 read out circuit of Figure 5 is used. Negative 10-pulse duration signals from *d* are applied to T_{16} and T_{17} and, with V_5 as shown, will appear only at the plate of T_{16} at the proper voltage level to operate the $T_1 \ldots T_3$ tubes of the e_1 and e_3 blocks as shown in Figure 5.

Description of the adder

The adder is connected so that it receives its input from two sources as shown in Figure 6. One source is the decoding distributor of the transmission system and the other is the output pulses from the switch-amplifier blocks, *e*, of the register selector. The adder's output is connected to the input pulse lines of the same blocks. Its purpose is to receive numerical information from the transmission system, add this to the contents of a register, and to transfer the sum back to the same register. The details of the adder circuit are not necessary here, since the adder is essentially a two decade accumulator such as described by Burks ("Electronic Computing Circuits," Proc. I. R. E. 35 : 756, August 1947) and by Brainerd and Sharpless ("The ENIAC," Electrical Engineering 67 : 163, February 1948). The block *i* represents a coincidence or switch circuit similar to those of $T_1 \ldots T_3$ in Figure 5 and allows a series of pulses to cycle the adder during the Write operation. This cycling is done so that the numerical contents of the adder may be transmitted as described in the above references. The symbols j_1 and j_2 represent diode buffers which prevent back coupling between the units and tens lines.

Special features of the central storage equipment

The foregoing sections have described the central storage equipment of the system. Certain outstanding features are set forth below.

(1) The use of a magnetic storage medium which permits compact storage of impulses, quite high pulse rates for reading pulses on and off, and easy erasure and reuse of the same material. This feature also has the advantage that there will be no loss of stored information in the event of power failure.

(2) The use of the disk form for the magnetic material. This is compact, easily assembled, and easily produced. Moreover, the disks can be rotated at high speeds, allowing a short recess time to any register.

(3) The use of more than one recording chan-

nal per disk which, for instance, permits the use of one pulse space per decimal digit in a 4-channel system.

(4) The use of a clock disk as the master source of pulses, which obviates all synchronizing problems between disks.

(5) The use of electronic counters and switching circuits which operate at pulse rates up to hundreds of thousands per second. Such high speed switching and counting permits the use of high pulse rates from the clock disk, thereby greatly speeding the operation of the whole system.

(6) The use of binary or base two combinations for the selection of registers. This means that each scale-of-two stage added to counter c will double the number of registers one can select.

General description of central transmission equipment

The central transmission equipment (Fig. 1) comprises three major components, the cycler, the decoding distributor, and the line selector. The cycler consists of a continuous pulse generator working in conjunction with a coincidence circuit which is under the control of the decoding distributor. The cycler will, when released by a signal from the line selector, give forth a continuous burst of a given number of pulses. These pulses cycle the decoding distributor and also go out over a line to a station where they are coded up as a group of timed pulses, or word, in the station equipment. They then return over the transmission line and are distributed into the proper channels of the central equipment by the decoding distributor. The line selector scans in turn each of the plurality of lines leading into the central equipment. When one of these lines is activated from a given station, the line selector will "lock-up" on that line and will release the cycler. It will remain on that line until it receives a "reset signal" from the register selector when it resumes its scanning.

Details of the cycler

Figure 9 shows in detail how the cycler operates in conjunction with the nine stage linear counter *m* of the decoding distributor to give out a group of 9 pulses to the transmission equipment. The block p represents a conventional pulse generator which may be of the multivibrator sort, and which continuously supplies positive impulses to one grid of tubes T_{1} and T_{2}. Tubes T_{1} and T_{2} are coincidence tubes, like T_{1} . . . T_{5} in Figure 5. For the present purpose it suffices to show only the cathode, two control grids, and the output plate of each tube. The second grid of T_{1} is directly connected to the negative output of stage 8 of counter *m*, so that it is cut off when *m* is on that stage. The second grid of tube T_{2} is cut off by the bias voltage supplied through the 100K resistor. Consequently no pulses from p can enter *m* nor the output circuit, except when a positive impulse from the line selector is applied to the second grid of T_{2} through the 0.01 capacitor, causing that tube to permit one pulse to pass. This pulse goes out the output and also steps the counter *m* from stage 8 to stage 0. Pulses now can pass through tube T_{2} until *m* arrives back on stage 8, when T_{2} will again be cut off and the device will lock up, awaiting another positive impulse on the second grid of T_{2}. It should be noted that this positive triggering pulse must have the duration of at least one pulse time and not more than eight.

This requirement is easily met by the proper choice of the values of the capacitance and resistance in the coupling circuit to the second grid of T_{2}.

Details of decoding distributor

Figure 9 also shows the decoding distributor. The tubes T_{3} . . . T_{11} are coincidence tubes, as mentioned previously, and for simplicity only the two input grids and the output plate of each tube are shown. As counter *m* steps onto 0, 1, 2 . . . 7, each one of the first grids is driven on in turn so that if a pulse is on the input line from the line selector during a particular part of the cycle, that pulse will appear at the plate of the tube whose first grid is positive. In this manner the pulses from the cycler, which have been time division coded into a word in the translating equipment of the station and are returning to the central equipment, are distributed either to the adder or to the coding switches S_{1} . . . S_{5}, which produce the previously-mentioned voltages V_{1} . . . V_{5}. It should be noted that the pulse arrives at the second grid of T_{3} . . . T_{11} simultaneously. It arrives there, however, delayed by the time of travel from T_{2} out over the transmission equipment, through the translation equipment, and back over the transmission equipment. Thus the pulse repetition period of *p* must be greater than the time of travel of the pulse over the route indicated. If this cannot be done without too great a sacrifice of speed, as for instance might be necessary for use with very long lines, extra stages may be added to *m* between 8 and 0 to take care of the initial delay. It will be noted that tubes T_{3}, T_{4} and T_{5} are connected together to the adder so that pulses in the first three time positions of the word enter the units decade of the adder. T_{6} . . . T_{11} are connected individually to S_{1} . . . S_{5} and thereby convert the last five pulses of the word into the voltages V_{1} . . . V_{5} which operate the register selector coincidence circuit.

Figure 10 shows a circuit suitable for use as the S blocks. It is a typical Eccles-Jordan trigger circuit which has two stable states, set and reset. When set the M output is positive and the L output negative. When reset M is negative and L positive.

A negative pulse applied to the J input will set the circuit while a similar signal on K will reset it. The voltages V_{1} . . . V_{5} of Figs. 7 and 8 are produced by the L and M outputs of *s*1 . . . *s*5 of Fig. 9.

Description of the line selector

The line selector used in the particular system disclosed is shown in Figure 11. Merely by way of illustration, the line selector is shown as being adapted to scan periodically three lines each consisting of a pair of wires balanced to ground. The line L_{10} and L_{11} is the one which extends to the typical station equipment hereinafter described. As shown the line selector is in the form of a commutator *q* which comprises input and output arms *r* and *v* on a common motor-driven shaft, and stationary contact segments engageable by the respective arms. Arm *v* makes continuous contact with ring 16, while arm *r* makes continuous contact with ring 11. These rings have external circuit connections as shown. Arm *v* also makes contact successively with three stationary contact segments 12, 13 and 14 which are insulated from one another. Arm *r* makes contact successively with stationary contact segments 18, 19 and 20 with which there are associated auxiliary segments 15, 16 and 17 respectively. The latter are connectable to their respective associated main segments through contacts 21, 22 and 23 of relay s_{1}. The purpose of the auxiliary segments will be explained presently. As the arms *r* and *v* rotate, they "scan" the three lines which are connected to the stationary segments. Each line consists of an input wire and an output wire as shown.

The input arm *r* is connected (through ring 11) to the grid of vacuum tube T_{10}, which is used to control the relay s_{1}. Arm *r* is also connected through to the input of tubes T_{6} . . . T_{11} of Figure 9. The output arm *v* is connected (through ring 10) to the output from T_{1} and T_{2} of the cycler, Figure 9. Both arms are also connected to the indicator circuits, T_{21} and T_{22}. The purpose of these tubes is to send positive pulses out on the line to operate the indicator lights at the keyboard positions, as will be described later.

The operation of the line selector is as follows. With the commutator revolving, the input arm *r* contacts a line with a positive potential on it, which indicates that the line is activated. This positive potential is thus applied to the grid of tube T_{10}, turning it on and drawing current through relay s_{1}, which picks up, opening the drive motor circuit and closing the contacts to the auxiliary segments on the input ring of the commutator. These auxiliary segments are vital to the action of this device. The commutator and motor have rotational inertia and will continue to move a short distance after the power is removed. If the auxiliary segments are not present, the selector might pick up near the end of one segment and the arm coast beyond, thus dropping the selector again without locking up. However, with auxiliary segments which are slightly longer than the maximum coast this objection is overcome. For now s_{1} will only pick up while the arm is on the main segment, and with the auxiliary segment switched in by the action of s_{1} the arm cannot coast by and drop s_{1} again. Of course the contact the arm makes in going from the main segment to the auxiliary segment must be of the shorting type. As s_{1} picks up, it also applies a positive potential to the capacitor input to tube T_{12} of Figure 9, thus releasing the cycler as described above. The line selector is released by either one of the indication signals resetting the keyboard at the station end of the line which removes the positive potential from the line and the grid of tube T_{10}, thus releasing relay s_{1}. The commutator is now free to continue its scan.

Description of the indicator signals

The indicator signals in the system described herein are quite simple. Their function is to indicate whether or not any total produced by adding a number from the station to the contents of a register exceeds 99. The signal which indicates the exceeding of 99 is called the alarm. The pulse indicating that it does not is called the end pulse. When an alarm takes place it is required that the old contents of the register be kept intact. The first step of the action of this system is for the word to arrive in the decoding distributor and the number part to be inserted in the adder. The second step, when the first register coincidence is made, is to read the register contents into the adder. This occurs while the counter *y* of Figure 5 is on 1. The third step is on the next register coincidence when *p* is on 2 and the register is erased. The final step occurs with the third register coincidence when *p* steps onto 3 and the contents of the adder are written into the register. At the end of this period the reset pulse resets the whole central equipment. The reset pulse is produced from the end pulse, as shown in Figure 11. The end pulse results from coincidence of a positive signal from stage 3 of *p* and a pulse from a_{1} of Figure 4. This pulse, which is negative, cuts off tube T_{23} of Figure 11, producing a positive indicator pulse on the "out" side of the line. This positive pulse produces a negative pulse at the plate of tube T_{23}, which is the reset signal. The indicator pulse thus produced occurs only when the sum in the adder, at the end of the second step, does not exceed 99. Similarly, the alarm produces an indicator signal on the "in" side of the line and a consequent reset signal. Here the alarm results from coincidence between the tens decade of the adder landing on zero and the 1 or read period of counter *y*, Figure 5. The reset signal thus occurs during the read step and prevents the other steps ever taking place. Moreover, the indicator signal sent out indicates that such has exceeded 99 because the tens decade of the adder can never land on zero unless that is so.

General description of station equipment

The station equipment comprises the position selector, the encoding distributor and a number of positions, each consisting of a keyboard and indicator panel. The keyboard provides the operator with a means for writing words—pulse groups carrying the desired information and identification of the register in which that information is to be inserted. The indicator panel provides a means for suitably displaying the information that is returned from the central storage equipment. The encoding distributor is used to distribute the continuous group of pulses arriving over the line from the cycler of the central equipment onto a number of wires which run into the keyboards so that the pulses may be coded into suitable groups. The position selector is a device which assures that no two positions can operate simultaneously, and in addition makes sure that each position gets a turn and that no one position can monopolize the line.

Description of encoding distributor

The encoding distributor of the disclosed embodiment of the invention is shown in detail in Figure 12. It consists of a nine stage linear counter *u*, similar to counter *m* in the decoding distributor of Figure 9. Its input receives the burst of pulses from the central cycler when the line is picked up by the central line selector. These pulses cycle *u* through its 9 stages, returning it to 8. From every stage but 8 the signal produced by the counter arriving at that stage is differentiated, producing a pulse which is amplified by one of the tubes T_{24} . . . T_{32}. There are eight wires, each carrying one of these pulses, leading through the buffing circuits *w* to the keyboards. These diode buffing circuits are necessary to prevent back circuits between the several keyboards. The counter *u* has associated with it a reset circuit *z*, which is activated to initially set *u* on 8 when the power is turned on. It should be noted that no such arrangement is needed in *m* of Figure 9, since that counter is part of the cycler and will automatically lock up on 8. It can now be seen that synchronism is maintained between counters *m* and *u*, since both receive the

same number of pulses from a single source and both start counting from the same position.

Description of keyboard and position selector

The eight wires from *w* are fed to a keyboard with push button contacts arranged as in Figure 13. Here the pressing of the appropriate keys connects several of the eight wires to a common output, thus providing a means for getting pulses on this output at different times in the cycle in order to produce a word. In the keyboard illustration of Fig. 13, the push buttons are represented at *a*, *b*, *c*, etc. The broken lines extending from the push buttons simply indicate the mechanical operator, such as a push rod, extending between the push buttons and the actuated contacts. The small circles 24 at certain intersections of the vertical and horizontal solid lines indicate the points at which connections are effected by the push buttons. It will be seen that some of the push buttons connect more than one of the vertical wires to the common output.

Fig. 15 better shows how the push buttons effect connection of the vertical wires to the horizontal wires. The push button *b* is shown, which connects two of the vertical wires to a horizontal wire through the medium of contacts 25 and 26.

Referring again to Fig. 13, the keyboard is also provided with a start button, A, which picks up relay s_3 when the position selector (Fig. 14) is in the proper position. When relay s_3 picks up it connects the 15K resistor to the output of the push button group and also connects this to the side L_{16} of the line leading from the station to the central equipment. At the same time it connects the input of counter *u* to the side L_{15} of the line leading back from the central equipment.

It will be noted that this K resistor serves as the plate load for tubes T_{26} . . . T_{34} (Fig. 12), and that since tubes T_{26} . . . T_{34} are normally biased to cut-off, the pulses appearing on the common keyboard line and which travel out to the central equipment are negative.

The operation of relay s_3 also connects the indicator panel to the two sides of the line and, in addition, operates the interlocking contacts 27 that prevent the other positions from picking up.

The operation of the position selector and this interlocking circuit is best understood by examining Figure 14. In this figure, the position selector is shown in conjunction with the relays s_3 of three positions. The motor-driven commutator 28 switches the power to each pick-up lead in turn. The power is fed from the grid-controlled rectifier T_{41} through the transfer contacts of the relays s_3. Thus, if any relay is picked up, its transfer contact is open and power is no longer fed to the commutator and thence to the pick-up lines of the other relays. Consequently no other relay can pick up. The relay is dropped out at the end of the process by a positive signal from the indicator (Fig. 13) triggering the thyratron T_{36} and momentarily cutting off the rectifier T_{41} removing all power from the relays.

The operation of the keyboard is as follows. The operator first depresses the push buttons selecting the register and giving the desired information. He then presses button A; relay s_3 picks up and thus applies a positive potential to the side of the line feeding arm *r* (Fig. 11) of the central line selector. The line selector picks up relay s_1 when arm *r* contacts the appropriate segment and the cycler (Fig. 9) gives out its burst of 9 pulses. These go over the arm *v* and its side of the line, through the contacts of relay s_3 to

counter *u*, which cycles producing one pulse on each of the eight wires in turn. These pulses are fed by the push button contacts of the keyboard onto the side of the line leading to arm *r* and thence into the decoding distributor where they are used as described previously. The central equipment now goes through its operation and an indicator signal is produced at T_{35} or T_{36} (Fig. 11) which returns through the keyboard relay s_3 and operates the lamps on the indicator panel.

The indicator panel

Figure 13 shows the indicator panel. T_{35} and T_{36} are thyratron tubes which are fired by the positive indicator pulses on the respective sides of the line. Since T_{35} and T_{36} are normally cut off they are not affected by the negative pulses of the word transmission. When T_{35}, or T_{36}, is fired the neon glow lamp T_{44}, or T_{45}, in its cathode is lighted and serves as a visible signal. The light will remain on after the relay s_3 has dropped out. T_{35} and associated circuit and relay contact are arranged so that a negative pulse from the contact closing turns off T_{35}, or T_{36}, when relay s_3 picks up. The 1N34 crystal diodes serve as buffing circuits so that either one of the positive indicator signals may trigger T_{36} of Figure 14 and drop out s_3.

Description of over-all operation

In the foregoing sections the various component parts of the system have been described. To better enable a clear understanding of the entire system, however, it is deemed advisable to describe the over-all operation.

The operator at any position in a station presses the keys on the keyboard to give the desired information. These keys latch up, making contacts as shown in Figure 13. The operator then closes the switch A, which starts the operation by picking up the relay s_3 if power is in the "pick-up" lead. This latter can only occur when no other position is active, as shown in Figure 14. As relay s_3 picks up, L_{16} is pulled positive by +75 volts through the 15K resistor, and by the same action the plate load and voltage is applied to the tubes T_{26} . . . T_{34} of the encoding distributor, Figure 12. The line selector, Figure 11, meanwhile is scanning each line and when it finds L_{16} positive, tube T_{26} turns on and closes relay s_1, locking up the line selector and applying a positive step of voltage to O_1, the input of the cycler, Figure 9. This step is turned into an impulse of sufficient duration to pass at least one pulse from the oscillator *p* through tube T_{18} to the counter *m*. This one pulse steps the counter off of stage 8, thereby opening T_{18}, which will remain open until the counter returns to that stage. Thus 9 pulses are passed through the connection I_1 and the line selector to L_{16}. These nine pulses on L_{16} return to the relay s_3, Figure 13, and through its circuits to the encoding distributor counter *u* of Figure 12. The counter steps through nine counts, putting one pulse in turn on each of the 8 grids of tubes T_{26} . . . T_{34}. Whichever of these tubes is connected in by the setting of the keys of the keyboard will send negative pulses through the contact of s_3 onto line L_{15}. These pulses are thus coded into a word. The word travels over line L_{15} through the line selector (Fig. 11) and connection O_3 to the decoding distributor, Figure 9. The first three pulses of the word are sent via I_3 to the units input of the adder, while the last five go to the electronic switches S_1 . . . S_5 to produce the selection voltages V_1 . . . V_5. As *m* arrives back on stage 8, it produces a positive pulse, which is applied to C_1 of Figure 4. A simple coincidence circuit, such as T_1, C_1 passes one of the 16 pulses per revolution from counter *b* of Figure 4, which sets S_6. S_6 is a switch circuit exactly like S_1. Its positive output is applied to T_{33} of Figure 7, thus passing the selector coincidence pulses only after a word has been received from a station. We now have a number in the adder, the V_1 . . . V_5 selection voltages set up, and S_6 set to pass a selector coincidence.

The first selector coincidence which now occurs produces a pulse at the plate of T_{33}. This pulse is of duration equal to ten clock pulses, or one register. This pulse steps counter *g*, Figure 5, onto 1 and makes coincidence in T_1, opening up the read circuits and sending the pulses stored in that register to the adder, where they add to the number already there. If the sum does not exceed 99, the process continues as follows. The next coincidence pulse steps *g* to 2 and, coincidence being made through T_2, the erasing circuits are activated and the contents of the register erased. On the next revolution of the disk a third coincidence pulse occurs. This steps *g* to 3, which opens the recording circuits and also the transmission circuits of Figure 6, as well as T_{39} of Figure 11. The circuits of Figure 6 cycle the adder, sending the sum into the recording circuits of Figure 5, and recording that sum in the register. At the end of this revolution, the single pulse from the clock disk and amplifier a_1 is applied to T_{39} in Figure 11, producing the end pulse, indicator pulse, and reset pulse as described. The reset pulse sets the switches S_1 . . . S_6 and the counters *g*, *e*, *b*, back to normal, thereby preparing the equipment for another turn. The positive indicator pulse goes out over line L_{16} through s_3 and to T_{45} of Figure 14. It lights T_{45} and also goes to T_{36} of Figure 14, where it drops out s_3 and frees the line, which in turn drops s_1 of the line selector by removing the positive voltage from L_{16}. This whole operation requires 9 pulse times of the transmission equipment pulses @ 1000 per second, i. e., 0.009 second, and 3 revolutions of the disk @ 30 revolutions per second, i. e., 0.1 second, plus pick-up and drop-out time of relays s_1 and s_3, i. e., 0.03 second. This gives a total of 0.139 second.

To retrace our steps a bit: If the sum of the adder exceeds 99 during the read period the tens decade will arrive on zero. This will produce a pulse at T_{38} of Figure 11. T_{38} is controlled by stage 1 of *g*, Fig. 5, so that an alarm pulse can only occur during the read period. When an alarm pulse occurs everything happens just as with the end pulse, except that the positive indicator pulse is on line L_{14} and lights T_{44}. Since everything is reset with the alarm signal, the action ceases then and the system skips the erase and records periods, leaving in the register the number that was previously there.

From the foregoing description, it will be seen that the invention provides an information storage system which embodies:

(1) A central storage unit consisting of a plurality of registers.

(2) Means for selecting these registers in accordance with a pattern of voltages on a group of wires.

(3) Means for reading from, erasing, and recording in a register.

(4) Means for adding numerical information to the contents of a register and returning the sum to the register.

(5) Means for obtaining that numerical information from a plurality of remote manually operated positions with no interference between positions.

(6) Means for manually setting up the above-mentioned voltage pattern from the said remote positions.

(7) Means for indicating to the operator at a position that the accumulated number in a register exceeds or does not exceed a given number.

(8) Means for releasing the equipment after one operation so that other operations may be performed.

It is believed to be novel to provide a completely automatic information storage system of such flexibility and speed as that disclosed herein. This system has been constructed and successfully operated. One of the tremendous advantages of this system is its speed, as it takes less than $\frac{1}{5}$ of a second for the complete operation to take place once the start button A has been pushed. In addition, it should be pointed out that the number of decimal digits can be increased very readily, with no loss of speed, by adding more decade units in the adder and more disks to the storage unit. Moreover, the number of registers it is possible to choose among can readily be increased to many thousands, sacrificing in speed only the time occupied by one word. This is a relatively short time, since even ordinary telephone lines can carry pulses at the rate of one thousand per second. Consequently a word containing 20 pulses, which would permit one to choose 2^{15} or somewhat over 32,000 registers and insert any digit up to five in the adder, would require only 20 milliseconds of the total cycle of $\frac{1}{5}$ second.

It will be understood, of course, that the invention is not limited to the particular embodiment shown and described, but is capable of various modifications and further embodiments without departing from its scope.

We claim:

1 In an information storage system, rotatable magnetic disk recording means including a plurality of registers adapted to receive numerical information and to have such information erased therefrom, means for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation with the rotation of said disk recording means, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

2. In an information storage system, rotatable magnetic disk recording means including a plurality of registers adapted to receive numerical

information and to have such information erased therefrom, a master magnetic disk rotatable synchronously with said rotatable disk recording means, said master disk having recorded thereon pulses corresponding in number and time sequence to said registers, means for producing from said recorded pulses different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation with the rotation of said disk recording means, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

3. In an information storage system, a central station, rotatable magnetic disk recording means at said station including a plurality of registers adapted to receive numerical information and to have such information erased therefrom, means at said station for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation with the rotation of said disk recording means, an operating station having a plurality of operating positions thereat, means under control of an operator at any one of said positions for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means for transmitting said pulses to said central station, means at said central station responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating at the operating position whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

4. In an information storage system, a central station, rotatable magnetic disk recording means at said station including a plurality of registers adapted to receive numerical information and to have such information erased therefrom, a master magnetic disk rotatable synchronously with said rotatable disk recording means, said master disk having recorded thereon pulses corresponding in number and time sequence to said registers, means at said station for producing from said recorded pulses different register-selection voltage combinations representative respectively of said registers, and occurring successively in timed relation with the rotation of said disk recording means, an operating station having a plurality of operating positions

thereat, means under control of an operator at any one of said positions for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means for transmitting said pulses to said central station, means at said central station responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating at the operating position whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

5. In an information storage system, a central station, a plurality of operating stations, a transmission line extending from each of said operating stations to said central station, a plurality of operating positions at each of said operating stations, a plurality of registers at said central station adapted to receive numerical information and to have such information erased therefrom, means under control of an operator at any one of said positions at any one of said stations for producing and sending over the line of said station a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means for preventing transmissions over the lines of the other stations during the operation at said one station, means for preventing operations at the other positions of said one station during the operation at said one position, means at said central station responsive to said pulses for selecting said register, means operable upon selection of said register for indicating at said one position whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

6. In an information storage system, movable recording means including a plurality of registers adapted to receive and store temporarily numerical information, means for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation with said movable recording means, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, and means for temporarily storing said numerical information in said register.

7. In an information storage system, rotatable magnetic disk recording means including a plurality of registers adapted to receive and store temporarily numerical information, means for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed re-

lation with said rotatable disk recording means, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, and means for temporarily storing said numerical information in said register.

8. In an information storage system, rotatable magnetic disk recording means including a plurality of registers adapted to receive numerical information, a master magnetic disk rotatable synchronously with said rotatable disk recording means, said master disk having recorded thereon pulses corresponding in number and time sequence to said registers, means for producing from said recorded pulses different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation with said rotatable disk recording means, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, and means for storing said numerical information in said register.

9. In an information storage system, movable recording means including a plurality of registers for temporarily storing numerical information, means for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation to said movable recording means, and means under control of an operator for selecting any one of said registers through the agency of said voltage combinations.

10. In an information storage system, rotatable magnetic disk recording means including a plurality of registers for temporarily storing numerical information, means for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation to said rotatable disk recording means, and means under control of an operator for selecting any one of said registers through the agency of said voltage combinations.

11. In an information storage system, rotatable magnetic disk recording means including a plurality of registers for storing numerical information, a master magnetic disk rotatable synchronously with said rotatable disk recording means, said master disk having recorded thereon pulses corresponding in number and time sequence to said registers, means for producing from said recorded pulses different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation to said rotatable disk recording means, and means under control of an operator for selecting any one of said registers through the agency of said voltage combinations.

12. In an information storage system, movable recording means including a plurality of registers adapted to receive numerical information and to have such information erased therefrom,

means for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation with said movable recording means, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

13. In an information storage system, a central station, movable recording means at said station including a plurality of registers adapted to receive numerical information and to have such information erased therefrom, means at said station for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation with said movable recording means, an operating station having a plurality of operating positions thereat, means under control of an operator at any one of said positions for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means for transmitting said pulses to said central station, means at said central station responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating at the operating position whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

14. In an information storage system, a central station, an operating station, a transmission line extending between said stations, a plurality of operating positions at said operating station, movable recording means at said central station including a plurality of registers adapted to receive numerical information and to have such information erased therefrom, means at said central station for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation with said movable recording means, means under control of an operator at any one of said positions for producing and sending over said line a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means for preventing operations at the other positions during the operation at said one position, means at said central station responsive to some of said pulses

for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating at said one position whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

15. In an information storage system, a central station, a plurality of operating stations, a transmission line extending from each of said operating stations to said central station, a plurality of operating positions at each of said operating stations, movable recording means at said central station including a plurality of registers adapted to receive numerical information and to have such information erased therefrom, means at said central station for producing different register-selection voltage combinations representative respectively of said registers and occurring successively in timed relation with said movable recording means, means under control of an operator at any one of said positions at any one of said stations for producing and sending over the line of said station a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means for preventing transmissions over the lines of the other stations during the operation at said one station, means for preventing operations at the other positions of said one station during the operation at said one position, means at said central station responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating at said one position whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

16. A system for magnetic storage of a plurality of data respectively relating to different items of information, comprising a magnetic member having a plurality of magnetizable data storage portions respectively assignable to said different items of information, a magnetic recording and reading device adjacent to said magnetic storage member for selectively magnetizing any of said data storage portions for storing data thereon or alternatively for taking a reading of data previously stored thereon, means for transmitting signals including item selection signals to said storage apparatus, means for causing continuous relative rotation between said magnetic storage member and said magnetic recording and reading device for continuously scanning said plurality of data storage portions, circuits separately operable through said magnetic recording and reading device for causing the device to record or read as desired, selective means responsive to the received signals for rendering a desired one of said circuits operable, and means including a gating circuit having space discharge

tubes and whose timing is controlled by the received selection signals and the instantaneous position of said recording and reading device relative to that of a data storage portion selected, thereby to effect a desired recording or reading operation.

17. In an information storage system, magnetic recording means having a plurality of information-recording sections constituting registers and also having a register-selection section on which are recorded pulses coordinated with said registers, means for producing from said recorded pulses different successively-occurring register-selection voltage combinations representative respectively of said registers, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

18. In an information storage system, a central station, magnetic recording means at said station having magnetic recording means having a plurality of information recording sections constituting registers and also having a register-selection section on which are recorded pulses coordinated with said registers, means for producing from said recorded pulses different successively - occurring register - selection voltage combinations representative respectively of said registers, an operating station having a plurality of operating positions thereat, means under control of an operator at any one of said positions for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means for transmitting said pulses to said central station, means at said central station responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, means operable upon selection of said register for indicating at the operating position whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein the sum of the erased number and the additional number which it is desired to store.

19. In an information storage system, magnetic recording means having a plurality of information recording sections constituting registers and also having a register-selection section on which are recorded pulses coordinated with said registers, means for producing from said recorded pulses different successively-occurring register-selection voltage comoinations representative respectively of said registers, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to some of said pulses for producing a pattern of voltages, means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register, and means for storing said numerical information in said register.

20. In an information storage system, magnetic recording means having a plurality of information recording sections constituting registers and also having a register-selection section on which are recorded pulses coordinated with said registers, means for producing from said recorded pulses different successively-occurring register-selection voltage combinations representative respectively of said registers, and means under control of an operator for selecting any one of said registers through the agency of said voltage combinations.

21. In an information storage system, spot magnetization recording means including a plurality of registers adapted to receive numerical information and to have such information erased therefrom, means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to said pulses for selecting said register, means operable upon selection of said register for indicating whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein by spot magnetization the sum of the erased number and the additional number which it is desired to store.

22. In an information storage system, a central station, spot magnetization recording means including a plurality of registers at said station adapted to receive numerical information and to have such information erased therefrom, an operating station having a plurality of operating positions thereat, means under control of an operator at any one of said positions for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means for transmitting said pulses to said central station, means at said central station responsive to said pulses for selecting said register, means operable upon selection of said register for indicating at the operating position whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein by spot magnetization the sum of the erased number and the additional number which it is desired to store.

23. In an information storage system, spot magnetization recording means including a plurality of registers adapted to receive numerical information and to have such information erased therefrom, manually settable keyboard means at a remote position, means operable cooperatively with said keyboard means to produce a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means responsive to said pulses for selecting said register, means operable upon selection of said register for indicating whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein by spot magnetization the sum of the erased number and the additional number which it is desired to store.

24. In an information storage system, a central station, an operating station, a transmission line extending between said stations, a plurality of operating positions at said operating station, spot magnetization recording means including a plurality of registers at said central station adapted to receive numerical information and to have such information erased therefrom, means under control of an operator at any one of said positions for producing and sending over said line a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register, means for preventing operation at the other positions during the operation at said one position, means at said central station responsive to said pulses for selecting said register, means operable upon selection of said register for indicating at said one position whether or not any number already stored in said register plus that to be stored exceeds a given number, and means operable only in the event that said given number will not be exceeded for erasing the number already in said register and for storing therein by spot magnetization the sum of the erased number and the additional number which it is desired to store.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,005,807	Smith	June 25, 1935
2,046,381	Hicks	July 7, 1936
2,224,244	Hicks	Dec. 10, 1940
2,353,089	Roth	July 4, 1944
2,359,617	Bryce	Oct. 3, 1944
2,432,224	May	Dec. 9, 1947
2,446,037	Ammann	July 27, 1948
2,587,532	Schmidt	Feb. 26, 1952

for ease of identification. (PX10)

In an information storage system,

1. magnetic recording means having a plurality of information recording sections constituting registers and also having a register-selection section on which are recorded pulses coordinated with said registers,

2. means for producing from said recorded pulses different successively-occurring register-selection voltage combinations representative respectively of said registers,

3. means under control of an operator at a remote position for producing a group of pulses indicative of a particular register and also containing numerical information which it is desired to store in that register,

4. means responsive to some of said pulses for producing a pattern of voltages,

5. means responsive coincidently to said voltage combinations and said voltage pattern for selecting said register,

6. and means for storing said numerical information in said register.

A vital feature of the magnetic data storage invention is the register-coordinator pulses which produce different, successively-occurring voltage combinations representative respectively of the registers for register selection.(ESE; PX10) This vital feature in the disclosed embodiment of this invention is the combination of the sector and coordinator pulses which operate a counter to generate the voltage combinations which represent the respective registers, and particularly the coordinator pulse which periodically resets the counter to zero. An essential feature

CERTIFICATE OF SERVICE

Three copies of the foregoing Appendix have been served under Rule 33 of this Court upon Mr. S.C. Yuter and Mr. Paul V. Niemeyer, attorneys for Respondent Technitrol, Inc. by depositing same in a United States mail box, first class mail addressed to their post office addresses of record.

Allen Kirkpatrick, III
Attorney for Petitioner